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DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

NOTES

ON THE

GRASSES AND FORAGE PLANTS

OF

IOWA, NEBRASKA, AND COLORADO.

BY

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U. S. DEPARTMENT OF AGRICULTURE,
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Washington, D. C., August 10, 1897.

SIR: I have the honor to transmit herewith and recommend for publication as Bulletin No. 9 of this Division, a report by L. H. Pammel, professor of botany in the Iowa Agricultural College, on the grasses and forage plants of Iowa, Nebraska, and Colorado. The three States included in this report, especially the first named, are great stock-raising States, and all information pertaining to the food supply—the grasses and forage plants—for the cattle, horses, and sheep can not fail to be of interest. This report is in line with the investigations of the grasses and forage plants of the Northwest now being carried on by the Division.

The report here presented is divided into three parts, the first including general observations upon the physical conditions and important questions relative to forage production in the States named; the second is devoted to an enumeration of the more important grasses and forage plants of these States, alphabetically arranged, with economic notes; in the third part the author presents a classified list of the grasses of Iowa, Nebraska, and Colorado collected by him during the seasons of 1895 and 1896.

Respectfully,

F. LAMSON-SCRIBNER,
Agrostologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

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One of the most important industries in the States of Iowa, Nebraska, and Colorado is that of stock raising, and consequently the forage and the conditions of the native forage plants are subjects of vital interest to the farmer. In order to study these conditions several of the more important points in Iowa west and northwest of Ames were visited at various times in 1895 and 1896, and in the latter year collections and observations were made in the vicinity of Omaha, Lincoln, Crete, Hastings, and McCook, in Nebraska, and also in northern and central Colorado in the vicinity of Fort Morgan, Greeley, Fort Collins, Golden, Denver, and Colorado Springs. Some time was spent in the foothills and mountains west of Fort Collins along the tributaries of the Cache la Poudre, at Clear Creek Canyon west of Golden, at Cheyenne Canyon not far from Colorado Springs, and on Pikes Peak.

IOWA.

GENERAL FEATURES OF CENTRAL AND WESTERN IOWA.

West of Ames there are several important valleys—the Des Moines, Coon, and Boyer; northwest of Carroll there are the Little and Big Sioux, the Maple, and the Floyd. Along the Coon and Des Moines rivers the country is rough, and but little hay is cut, though much of the timber land is used for pasture. Along the Boyer, Maple, and Floyd rivers the immediate banks contain some timber, but the flood plains are open and covered with a luxuriant growth of grasses.

The forage question in central Iowa is very different now from what it was fifteen years ago. At that time considerable areas of unbroken sod still remained. Now the wild prairies have almost ceased to be a factor in the production of hay. The extensive prairies have given way to cultivated fields and pastures. Small unbroken areas occur here and there, but these are chiefly confined to the small drainage basins between hills, and exist largely because in times of considerable precipitation these depressions are too moist for proper cultivation. The Boyer and Maple valleys are noted for the large crops of wild hay

annually produced. The same may be said of the rich alluvial flood plain of the Missouri. This plain varies from a few to 15 miles in width, the average being from 8 to 12. The hay crop constitutes one of the chief sources of revenue for the farmers of this region, and could be made much more important if they would follow a more rational system of cropping.

The chief hay plants cultivated in central Iowa are Timothy, Redtop, Blue-grass, and Red Clover. The principal plants used in pastures are Blue-grass, White Clover, Redtop, and Timothy. In the Boyer and Maple valleys and on the Missouri bottoms the wild grasses predominate. To a limited extent, alfalfa meadows have been started in Carroll, Ida, and Woodbury counties. The loess hills, skirting the Missouri bottoms, are mostly cultivated, though unbroken wild meadows and pastures still remain. In the eastern portion of this district considerable corn fodder is used as forage, the amount used depending largely upon the condition of the pastures and meadows.

Many other grasses have been tried with varying success. Orchard grass, naturalized in many places, is one of the most successful. Tall Oat-grass gives some promise. Perennial Rye-grass is nearly worthless for this section of the State. Italian Rye-grass is unable to resist the cold of our winters and is a complete failure. Meadow Foxtail (*Alopecurus pratensis*) does fairly well as an early grass when sown the season before, but is hardly adapted to this section. The most promising of the recently introduced grasses is Smooth or Hungarian Brome. The Short-Awned Brome has also been tried and is very promising. Rye and Barley are often used as forage plants. German millet and Hungarian-grass find extended use some seasons. Broom-Corn Millet is frequently sown in northern and northwestern Iowa.

But one legume is generally grown, and that is Red Clover. Mammoth, or Medium, Clover is often sown, but is much less common than the preceding. Alsike Clover is becoming more common. Two sweet clovers are not infrequent; the White Sweet Clover is more abundant than the yellow. Crimson Clover has been tried repeatedly, but is not adapted to Iowa conditions. It suffers much from drought in late summer, and from insect and fungus enemies.

Many native species of grasses occur, and they vary in quantity and quality in different sections of the State. The dominant grasses of central Iowa are Little Blue-Stem and Big Blue-Stem. Both of these species are frequently called Blue-Joints. Several species of Elymus are abundant, as Wild Rye, on the prairies and meadows; Lyme-grass on the flood plains of streams, and Dennett-grass along the borders of woods. Other common grasses are: Indian Beard-grass, or Bushy Blue-Stem, in prairies and open woods; Tall Grama-grass of the dry prairies and gravelly knolls; Nodding Fescue in woods; Slender Fescue in dry sterile soils; Short's Fescue in low prairies, a most valuable species; Switch-grass in rather moist meadows; Satin-grasses (*Muhlenbergia racemosa*, *M. diffusa*, *M. willdenovii*, and *M. mexicana*) in moist

soil of open woodlands and meadows; Swamp Chess in open woodlands; Fowl Meadow-grass in low grounds along streams; Wire-grass and Squirrel-tail-grass, an introduced species, in meadows and waste places; Blue-Joint, Reed Canary-grass, Common Reed-grass, and Floating Manna-grass in marshy places and shallow water; Large Rush-grass and Bunch-grass in dry prairies. In northwestern and western Iowa the above as well as some additional species occur. Among the latter are Western Wheat-grass, Bearded Wheat-grass, Blue Grama, Slough-grass, and Big Sand-grass.

The most widely-distributed of all the native leguminous plants is Canadian Rattle-weed (*Astragalus canadensis*), a thrifty, hardy, and vigorous species found in woods, low meadows, and prairies. It is eaten by stock, but becomes rather woody when old. Buffalo Pea, or Ground Plum, is common on dry sterile hills throughout the region and affords valuable forage. American vetch is one of the most valuable of the native legumes. It grows in the moist soil of low prairies and open woodlands. This vetch is well adapted to the conditions of western and northwestern Iowa, and does well under cultivation. The prairie clovers (*Petalostemon violaceus* Michx., and *P. candidus* Michx.) are common on the prairies everywhere, as also on the loess soils of western Iowa. These plants are seldom eaten by stock unless forage is scant. *Dalea alopecuroides* Willd. is common throughout the loess region and has been introduced farther eastward. Wild vetch, well known as a valuable forage plant of the Northwest, is indigenous to the loess, though not abundant except locally. It has been introduced into Boone County. Running Buffalo clover (*Trifolium stoloniferum* Muhl.), a native, is considered a valuable forage plant by the farmers of western Iowa, and is worthy of a trial under cultivation. Mention should also be made of a Loco plant (*Oxytropis lambertii* Pursh.) native to this region. Though often consumed by stock, no complaints have been made that it produces loco poisoning. Rattlebox (*Crotalaria sagittalis* L.) occurs in the more sandy bottoms of the Missouri River. Complaints have frequently been made of the trouble it causes when fed to horses. The disease it produces has been called "crotalism."

OBSTACLES IN THE WAY OF GROWING NATIVE FORAGE PLANTS.

There are some serious obstacles in the way of maintaining the native meadows and pastures of Iowa. These may be classed under two heads—the overstocking of pastures and the growth of weeds. Many farmers attempt to raise more stock than their pastures will safely accommodate. The grasses can not endure the close grazing and excessive trampling to which they are subjected, and consequently they die out. Snow in this section of the State is usually blown from the open fields soon after falling, and hence can not be depended upon to protect the grass roots in pastures that have been too closely grazed. As a result of this, weedy annuals, like Southern Poverty-grass, Foxtail and Squirreltail spring up to take the place of the better perennial

species, or the native ragweeds and verbenas spread and occupy the soil. All of these have become so plentiful that farmers remark on their more frequent occurrence now than in former years. Several rank-growing weeds are abundant in meadows and pastures of western Iowa. Sunflower and Marsh Elder find in the rich alluvial soil of the river bottoms a most congenial place for their development. They are especially troublesome on land that is often flooded during spring freshets. It may be that farmers of this region who rely chiefly on the hay crop will be obliged to introduce better turf-forming grasses, such as can resist the inroads of these weeds. From what I have seen of Blue-grass in this region it may prove a good grass for this purpose and Hungarian Brome (*Bromus inermis*) may prove to be of even greater value. Snow-on-the-Mountain (*Euphorbia marginata*), a well-known ornamental plant, is a serious pest in western and northwestern Iowa. Golden Rods are often troublesome in pastures, especially *Solidago canadensis* and *S. rigida*. Stock will not eat them unless forced to do so, and when once well established in the pasture they are very difficult to eradicate.

NEBRASKA.

THE FORAGE PROBLEM.

The forage problem of Nebraska is one of peculiar interest. A great variety of native species occur because of the diversified climate and soils of the State. Observations were made in the vicinity of Omaha and thence southwest to Lincoln, Crete, Hastings, and McCook to the Colorado line. The rich, fertile bottoms along the Missouri, the rolling prairie west of Omaha, the fertile valleys of the Platte, Salt, and Blue rivers, the salt marshes in the vicinity of Lincoln, the vast stretch of level prairie about Hastings, the flood plain of the Republican River, with the rolling clay hills that rise from this valley, the narrow canyons, and the sand hills in the western part of the State are striking illustrations of the varied features of this region. Grazing is now, and ever will be, an important industry in the western half of the State. Although the grasses may not grow so luxuriantly season after season in Nebraska as in Iowa, the climate is more favorable for winter grazing than in the latter State, and there is a large number of valuable species of native forage plants.

NATIVE GRASSES.

It will not be necessary to discuss the forage plants of eastern Nebraska, as the conditions are similar to those in Western Iowa, and the foregoing remarks will apply to this region.

In the central and western parts of the State the farmer relies chiefly on the native forage plants. I was unable to find a single introduced grass superior to Grama-grass, Wild Wheat, Turkey-foot, Big Blue-Stem, and Buffalo-grass. I was strongly impressed with the fact that the grasses best adapted to this climate are the native species. In

alluding to the value of our native grasses to obtain improved forms, Prof. F. Lamson-Scribner says:

Nearly all of our cultivated forage plants are of foreign origin, and if it were not simply a matter of public interest, it ought to be one of public sentiment to preserve for the coming generations of American farmers these native species which have added so much to the wealth of the land in the past. The species in the grazing regions in the west and southwest, and for that matter, in every part of this country where sheep or cattle are raised, are best adapted for the conditions under which each grass grows, and it is folly to think that better forms may be introduced from Europe or Asia or Australia, where climate and soil and abundance of rainfall are different. The meadow grasses of the parks, woodlands, and mountain slopes, the Grama and Buffalo grasses of the southwest and the Blue-stems of the eastern prairie belt, can not be improved upon.

It certainly seems to me that the time has arrived for us to consider the advisability of saving from extermination the numerous valuable forage plants found in the arid and subarid portions of our country. The long-continued existence of these grasses shows that they are adapted to the climate in which they occur. For ages these valuable grasses have defied unfavorable climatic conditions and have stood the tramping and grazing of vast herds of buffaloes.

Central Nebraska is very favorably situated for grazing. The soil in this section is productive, as is evidenced by the fine crops of corn and small grain which have been grown here under favorable climatic conditions. Influenced by these fine crops, settlers occupied the country and the valuable native turf was turned under and the land devoted to the growth of small cereals and corn. The results in many instances have been anything but satisfactory. No method of agriculture or human agency can control weather. The ordinary cultivated crops can not be produced with a scant rainfall. The semiarid belt is superb as a grazing country, unexcelled west of the Missouri. A crop of grass is just as certain here as corn is in eastern Nebraska. The climate is favorable for winter grazing and stock will need little attention. The crop can not be as large as under conditions of greater moisture, and the grazing lands must be kept under certain restrictions. Business men and intelligent farmers with whom I have conversed believe that the only salvation for this region is the stock industry. It will take some years to again see the turf-forming grasses cover the field where the plow has destroyed the sod which was many seasons in forming. Some believe that they will never return. It requires time to reestablish a prairie, just as it does a forest, when once burned over, to become covered with trees again. Annuals appear first, some nearly worthless, but these prepare the way for the better perennials, like Blue-Stem and Grama.

COLORADO.

CENTRAL AND NORTHERN COLORADO.

The conditions prevailing in central and northern Colorado are so different that the subject can not well be discussed under one head. In northeastern Colorado the conditions are much the same as in west-

ern Nebraska. In the semiarid regions considerable areas were at one time cultivated, but, after a few years of unsuccessful attempts at raising corn, oats, and wheat, the land has been allowed to revert to grass. The several branches of the Republican River rise in the sand-hill region of eastern Colorado. This section of the State has become famous as a stock country and is seemingly prosperous. Nearly every farmer is provided with a neat house. Windmills are numerous for the purpose of providing water for the stock. The country to the north, drained by the Platte, is likewise largely devoted to the cattle industry. The most conspicuous grasses are considered in detail elsewhere in this paper. Though the rainfall is limited, there are thousands of acres of fine meadows and grazing lands covered with a dense growth of Grama-grass. In some places this grass would yield a ton of hay to the acre.

FORAGE CONDITIONS OF THE PRAIRIES AND SAND HILLS.

Turkey-foot-grass, or Big Blue-Stem, 4 to 5 feet high, grows very luxuriantly over the sand hills. Western Wheat-grass, from 2 to 3 feet high, grows on the open prairies where not pastured. The year 1896 was certainly most favorable for the growth of these wild grasses. Such a season demonstrates what this region can do in the way of grass production. In Washington County, in the vicinity of Akron, with a higher altitude than at Robb, Wray, and Yuma, the ranges were in excellent condition, though not as good as in the sand-hill region. In the vicinity of Fort Morgan the range conditions were not so good; there was less rainfall and the grasses were closely cropped. Still the region afforded some good grazing, consisting chiefly of Blue-Stem, Indian Millet, Western Wheat-grass, Blue-Grama, Buffalo-grass, Wild Rye, Feather Bunch-grass, and Needle-grass.

In the country surrounding Fort Morgan the ranges are chiefly used for sheep raising. Along the Platte to the east and west are several large irrigation ditches. The chief forage plant grown here is alfalfa. Too much praise can not be given to this plant. There are thousands of acres of it. Three crops are cut in a season, and the hay brings from $3.50 to $4 a ton. In many cases the farmers allow their sheep to run on the range in the summer and in the winter feed them on alfalfa hay.

Greeley and Fort Collins in northern Colorado are famous for the large areas under irrigation. Some of the most valuable irrigated lands of the State are located here. The principal streams supplying water for irrigation are the Platte, Cache la Poudre, Big Thompson, Clear Creek, and Boulder Creek. Here, as elsewhere east of the mountains, alfalfa is one of the chief crops. At several points dairying is an important industry, and the fattening of sheep and cattle on alfalfa is assuming considerable importance. The fact that alfalfa is a bulky crop makes it more profitable to ship cattle to points where this crop is grown than to ship the fodder great distances. It would seem, however, that Colorado can not at present produce enough alfalfa to supply

her own demands. A great deal of range stock is shipped out to be fattened in Iowa, Nebraska, and other States.

Three Brome grasses are becoming established in the vicinity of the Colorado Agricultural College. Two of these, Hungarian Brome (*Bromus inermis* L.) and Rescue-grass (*Bromus unioloides* Willd.), are valuable forage plants. The third (*Bromus tectorum*) is a weedy annual on the grounds of the experiment station. Many of the cultivated species such as Timothy, Redtop, Blue-grass, and Orchard-grass, are naturalized in many places, but farmers, as a rule, do not make a business of growing these grasses, as they do not thrive without irrigation. Alfalfa occasionally grows where the soil has not been irrigated for a season, but the growth is so poor that it is often not worth the cutting. Several other leguminous plants are common. White Sweet Clover is a weed in many of the irrigated districts. Yellow Sweet Clover is less common than the White. Neither of these, so far as could be learned, is used for forage.

A large number of native grasses occur along irrigating ditches and streams, and many of them are highy nutritious. One of the most conspicuous is Slender Wheat-grass, which grows to a height of 3 to 4 feet and produces a large number of leaves. The Western Wheat-grass is also much more productive in such situations than in high and dry soil. Feather Bunch-grass grows luxuriantly. Wild Rye is a large and coarse grass of little value when compared with many of the other species noted here. In low, swampy places Slough-grass grows from 1 to 4 feet high, and makes fine hay. *Polypogon monspeliensis* Desf., a weedy annual, also occurs along irrigating ditches. *Catabrosa aquatica* is an aquatic grass of irrigating ditches and wet canyons in the foothills. These have been disseminated on the plains by water brought from the mountains. Macoun's Rye-grass (*Elymus macounii* Vasey) occurs in the flats along the river courses. Cord-grass occurs in low ground and Slender Cord-grass is sparsely represented in alkaline marshes. Fowl Meadow-grass is abundant in the fields in the vicinity of Fort Collins and Golden. Squirrel-tail-grass is plentiful in seepage meadows and is a noxious weed when the bearded "heads" have formed, though it is of some value when young. The common Reed-grass occurs in quantity in the low meadows, but it is of little agricultural value. The marshes contain numerous sedges and rushes, as *Carex marcida*, *C. ajuncis*, *Scirpus lacustris*, and others. Several species of Juncus are also common.

GRASSES AND FORAGE PLANTS OF THE FOOTHILLS AND MOUNTAINS.

The foothills, as well as the higher mountain slopes, produce a large number of valuable grasses. The grass flora is not equally rich throughout, that of the higher altitudes being more varied and richer as to species and quantity. The low foothills which rise from the prairies have many species in common with the prairies. It is only in the

canyons that one meets the larger and less common grasses. The grasses of the dry foothills generally grow in small bunches, but they are surprisingly nutritious. Notwithstanding the dry weather prevailing in the foothills during the month of June, 1896, cattle were in most excellent condition, which indicated that they had been fed on forage of superior quality. The conditions are such as one occasionally finds in the case of Blue-grass during a dry season in the Eastern States, the leaves of the grasses, though perfectly dry, containing an abundance of nutriment. In the narrow canyons and wider valleys a more luxuriant growth was observed, and where stock were not allowed to graze the meadows were in fine condition. The larger valleys up in the mountains are mostly taken up by homesteaders, who select this land since they can here raise a crop of two-rowed barley. This barley is cut and used for hay. The larger wild grasses growing in these meadows are used in a similar way. During the summer the cattle range on the mountains, and in the winter are fed on the hay made in the valleys. Not only do ranchmen grow cattle for beef, but at the lower altitudes dairying is carried on and the butter made finds a ready sale in the mountain towns.

In the lower foothills large areas of pine and Douglass spruce have been to a great extent removed. Several small shrubs, such as Ninebark (*Physocarpus torreyi*), Raspberry (*Rubus deliciosus*), *Purshia tridentata*, and *Jamesia americana*, are common. *Purshia tridentata* is frequently browsed by cattle; in fact many of the plants are picked bare. The chief pine at lower altitudes is *Pinus ponderosus scopulorum*. When not too dense, these woods furnish excellent grazing. At higher altitudes, about 8,500 feet, *Pinus ponderosus* is the principal tree. The woods are usually open enough to allow a growth of grass underneath, and make good ranges, especially since there are numerous small openings, where species adapted to moist soils grow. It has frequently been stated that the burning of these forests is conducive to a good growth of grass. This is true only in mountain meadows. A forest burnt over is absolutely sterile for a term of years, as far as forage plants are concerned. The fire not only destroys whatever turf there is, but it prevents reseeding. Such burnt forests are at first largely covered with various fireweeds, which are of little or no value for forage. In the course of years the character of vegetation changes; grasses and little shrubs appear, then the Trembling Aspen (*Populus tremuloides*) comes up; it soon becomes so thick that but little else will grow, and cattle find little pasturage. A fire, therefore, destroys for a period of years all hope of good forage, and it is to the interest of the ranchman that the forest should not be burnt over. The grasses most suited for these regions are such as are indigenous here; in fact there are few evidences of naturalization. Timothy is not uncommon in the foothills, but was found in only one locality at an altitude of 10,000 feet, along one of the mountain trails. White Clover was also found at nearly the same altitude under similar conditions.

The mountains are marked by extremes of temperature. Early in July, at an altitude of 8,500 feet, it is not uncommon to have the thermometer fall to 40° F. during the night. On the Little Beaver, one of the small mountain streams that finds its way into the south branch of the Cache la Poudre, at an altitude of 9,500 feet, the thermometer registered 38° F. in the morning, and yet at noon, in an open meadow, it was 110° F., most uncomfortably hot. Under such conditions Buffalo Bunch-grass grows to magnificent proportions. Western Bromegrass and Swamp Chess formed large patches. The little Mountain Timothy grows in large masses in the moister woods below. Few of our cultivated grasses can grow under such changeable conditions without losing vitality. At an altitude of 8,500 feet, lower down on Beaver Creek, barley made a poor growth. It was scarcely 6 inches tall, while Buffalo Bunch-grass was not only in flower at 9,500 feet, but seed was forming. How much better to have started a meadow of this bunch-grass than to sow barley every spring.

Three indigenous clovers (*Trifolium nanum*, *T. parryii*, and *T. dasyphyllum*) occur in northern Colorado. The first is a dwarf species of Pikes Peak at and above timber line. The two larger species cover the ground in perfect mats, and are valuable forage plants. Our horses fed on these clovers in preference to the grasses and sedges growing in the vicinity.

CHEMICAL COMPOSITION OF SOME COLORADO FORAGE PLANTS.

The chemical composition of a few Colorado grasses from chemical analyses made at the Colorado Agricultural Experiment Station is as follows:

Analyses of some Colorado grasses.

Grasses.	Water.	Ash.	Fat.	Albuminoid nitrogen.	Crude fiber.	Nitrogen-free extract.
Grama grass (*Bouteloua oligostachya*)	7.33	7.31	1.73	7.51	14.62	68.33
Buffalo grass (*Bulbilis dactyloides*)	7.80	10.33	2.25	7.54	14.59	65.29
Western Wheat grass (*Agropyron spicatum*)	7.91	7.09	2.57	7.32	19.65	63.37
Slender Wheat-grass (*Agropyron tenerum*)	7.86	6.28	2.04	6.15	20.20	65.33
Prairie June grass (*Koeleria cristata*)	8.15	7.96	3.93	6.85	22.58	58.68
Mountain Timothy (*Phleum alpinum*)	7.87	6.30	2.60	10.67	16.91	63.52
Slough-grass (*Beckmannia erucæformis*)	8.36	6.21	3.05	8.53	22.65	59.56
Lupine (*Lupinus plattensis*)	9.87	9.17	1.98	13.68	17.93	57.24
Alfalfa (*Medicago sativa*)	10.92	17.27	7.69	8.00	16.16	58.88
Bokhara Clover (*Melilotus alba*)	8.75	7.39	3.65	17.85	14.04	57.07

The above analyses show that these native grasses vary considerably in composition, but that they compare very favorably with cultivated ones.

The forage problems awaiting solution are numerous, and the farmers and stock men are just beginning to realize the importance of work along these lines. It has frequently been urged by the Chief of the Division of Agrostology that more exact and definite data on many of our wild grasses and more experimental work in the improvement of the native grasses are needed. If by selection from the native

grasses an improved form of Western Wheat-grass or Grama grass can be introduced into the "semi-arid" region which will give greater returns than those already there, the live-stock industry will be put on a better basis and its success assured.

LIST OF THE MORE IMPORTANT GRASSES AND FORAGE PLANTS OF IOWA, NEBRASKA, AND COLORADO, WITH ECONOMIC NOTES.

Alfalfa (*Medicago sativa*) (fig. 1): This valuable legume is spontaneous only in the most favored places in central Iowa, but is more frequent from Carroll west, especially in the loess soil along the Missouri. The fact that it persists for some years is evidence of adaptability. As a cultivated plant, it has met with moderate success in a few places in Carroll, Audubon, Monona, Woodbury, Pottawattamie, and Harrison counties. I saw several good-sized fields in the Missouri River bottom, near Sargent's Bluff, in Woodbury County. The first crop was ready to cut by the 18th of June. The Missouri bottoms are favorable to the growth of alfalfa because permanent water is reached at a depth of 10 to 12 feet. The only difficulty in the way is that these bottoms are subject to overflows; the water during some seasons stands for days on the soil in low places. It is possible that the higher locations might be admirably suited for the growth of this crop. In fact, good crops were observed on the higher lands. The soil of the bluffs along the Missouri is commonly known as "loess." It is not peculiar to western Iowa, but occurs abundantly along the Mississippi and other Iowa streams. Loess is a fine homogeneous soil, free from pebbles or other adventitious matter, very friable, so much so that it may be turned with the spade. It stoutly resists weathering, and stands in vertical faces for years. Though the surface dries quickly, this soil retains water in a remarkable manner.

FIG. 1.—Alfalfa (*Medicago sativa*): *a*, seed pod seen from the side; *b*, seed pod seen from above; *c*, seeds.

These loess bluffs rise rather abruptly from the rich and fertile Missouri bottoms and extend as undulating hills for several miles east. In this region, which is comparatively narrow, a peculiar vegetation exists, peculiar at least for the State of Iowa. It is more western than eastern. It is here that alfalfa has succeeded best, and is perhaps destined to play an important part in the agriculture of the counties bordering on the Missouri. There are some difficulties to contend with in Carroll and Harrison counties, and this is true also to some extent in Pottawattamie County. The humidity of the atmosphere is somewhat greater than in Woodbury County. Accompanying this humidity there is a greater rainfall, and a greater rainfall makes the plant more subject to the attacks of the Spot Disease (*Phacidium medicaginis*). This fungus disease causes a premature falling of the leaves, and hence lessens its value as a forage plant.

Alfalfa is the most valuable acquisition to the leguminous forage plants of Nebraska. The frequency of naturalized specimens throughout the region in which I made observations certainly indicates that the plant is at home. Fine fields of it were observed not only in the lowlands along the Republican Valley, but also on the uplands. Its culture, however, was most successful on the flood plains of the river and under irrigation. It produces a fair crop without irrigation some years, but on the uplands, year after year, it can not be depended on. In the Republican River Valley the water level is from 8 to 10 feet below the surface. The roots easily reach this depth. Under favorable conditions three crops can be cut in a single season, but where the field is irrigated three crops are certain, and I was informed that it affords almost twice as much money return per acre as corn. A farmer with 40 acres of irrigated alfalfa can make a comfortable living in this part of the State. In the country east of the semiarid region considerable alfalfa has been grown, and, so far as I was able to learn, with good success. No other perennial forage plant has given to the farmer of this region the same amount of satisfaction as has alfalfa. It is certainly destined to play an important part in the forage problem in Nebraska.

Alsike Clover (*Trifolium hybridum*) is occasionally grown in Iowa, but is not as yet common. It is spontaneous in many places and is best suited for rather low grounds, frequently associated with White Clover and Red-top. It will probably never take the place of Red or White Clover in the State.

Barnyard-grass (*Panicum crus-galli*). This grass, although usually regarded as a weed, is frequently used as a forage plant in western Iowa. It occurs abundantly as a roadside and garden weed in central Iowa, and is a conspicuous grass in sloughs and in cornfields in the Missouri bottoms. Hundreds of tons of this grass

might have been cut in Iowa this year. It is not always so plentiful, since the rains are usually less frequent in July and August.

Bearded Wheat-grass (*Agropyron caninum* R. & S.) is common in northwestern Iowa. It contributes somewhat to the native hay, but is of little value. In Colorado it is also common, even at an altitude of 9,500 feet. It is not so large as Slender Wheat-grass and grows in drier places. A closely allied species, *A. richardsoni* Schrad., occurs also in the mountains and compares favorably in forage value to *A. caninum.* Wire Bunch-grass (*A. divergens* Nees) is common in Clear Creek Canyon, near Golden, Colo., and is a grass of considerable value.

FIG. 2.—Big Blue-Stem (*Andropogon provincialis*): *a*, a pair of spikelets; *b*, first empty glume; *c*, second empty glume; *d*, third glume; *e*, fourth or flowering glume; *f*, palea; *g*, lodicules.

Big Blue-Stem (*Andropogon provincialis* Lam.) (fig. 2) is a common species throughout central and western Iowa. Wherever a bit of prairie remains this grass grows in abundance. It is a variable species, growing in bunches 3 to 8 feet high, and producing a large number of fine leaves. It occurs on the high, rolling prairie, rocky, open, wooded hillsides, and along the alluvial creeks and river bottoms. Blue-Stem is an important factor in the wild hay made in the Missouri bottoms, especially in the northwestern part of Iowa. It is liked by stock both as green forage and as hay. For horses many farmers prefer it to timothy. Blue-Stem hay brings a higher price in the market than any other wild hay. The grass was common about Lincoln, Nebr., and was observed as far west as McCook. It is a most excellent grass for the moister portions of the State, producing a large percentage of the wild hay as well as affording much of the pasturage. Near McCook, Nebr., it produced a fine growth in the flood plain along the Republican River. It requires a richer soil than the Turkey-foot grass.

Big Sand-grass (*Calamovilfa longifolia* Scribn.) is not common in central Iowa, though rather common in northwestern and western Iowa, where it abounds along railroads, on dry sterile soil, and steep hillsides. It often does good service in binding the loose soil together. As a forage plant it is of little value, the culms and leaves being very tough. In Nebraska it is common in the sand-hill country and also in the sandy marshes of the Republican Valley.

Black Grama (*Bouteloua hirsuta* Lag.) is common in the sand-hill region of western Nebraska. It forms dense tufts of fine leaves. It is nutritious, like the other gramas, and fills an important place on these poorer soils.

Blue Grama (*Bouteloua oligostachya* Torr.) (fig. 3) grows from 8 to 18 inches high, varying somewhat with seasons. It was much taller on the average in 1896 than in 1895. As a rule this grass seldom exceeds a foot in height. It is endowed by nature with great drought-resisting qualities. Around Crete and Lincoln, Nebr., it is common on dry soil and on gravelly knolls. At Hastings, Nebr., it is a dominant grass in meadows and pastures. The same may be said of it from McCook to the west line of Nebraska. As a pasture grass it is excellent, being nutritious and standing trampling better than Western Wheat-grass. A few years of selection under cultivation would no doubt produce a form equal to many of our cultivated grasses. Stockmen inform me that cattle thrive on this grass all winter in western Nebraska. In Colorado it is common in the foothills, especially between 5,000 and 6,500 feet altitude. Some plants were seen on an open prairie in northern Colorado at an altitude of 7,000 feet. Near Golden it was likewise observed at an altitude of 7,000 feet. It is common also at Colorado Springs, north of

FIG. 3.—Blue Grama (*Bouteloua oligostachya*): *a*, empty glumes of a spikelet; *b*, spikelet with the empty glumes removed.

Cheyenne Canyon, at an altitude of 6,500 feet. It usually grows much shorter than at lower altitudes.

Blue-joint (*Calamagrostis canadensis* Beauv.) is plentiful in Iowa only in low swales and second bottoms, where it commonly grows from 3 to 4 feet high, forming an abundance of leaves, well liked by all kinds of stock. The leaves keep green till late in the season, and the hay is not objectionable because the leaves and culms are not dead at the time when hay is usually made, as is often the case with Wild Rye.

Broom-corn Millet (*Panicum miliaceum*) is seldom cultivated in the central district of Iowa, though used more extensively in northern and northwestern parts of the State. It does well in dry years, and as a productive crop should commend itself.

Buffalo Bunch-grass (*Festuca scabrella*). This species at higher altitudes is the bunch grass par excellence. It is abundant on the Little Beaver in northern Colorado, at an altitude of 9,500 feet, where it occurs in open, sunny places and grows from a foot to 4 feet in height. The blades are often a foot long. The whole plant is more or less glaucous, which adds to its striking appearance. Professor Crandall, who is familiar with the plants of this region, states that several years ago, when stock had not grazed so far up the mountains, this grass occurred in great quantity in the open, sunny places at an altitude of 9,500 feet. Very few good specimens could be found, because almost every blade had been closely cropped. The Rocky Mountain Husbandman has this to say of Bunch-grass:

> The cured grass retains its nutriment all winter, owing to the fact that we have no drenching rains in the fall to bleach it—the light snows which come in early winter and melt off soon only serving to moisten it and make it more palatable. When we have late summer rains and the grass remains green until fall, should frost come early it is injured and stock do not seem to keep in such good condition during the winter as when it dries up early, as is generally the case. During the winter the lowlands and sharp foothills are for the most part free from snow. Usually the snow is cleared away by the wind except that which is driven into the thick clusters of grass. * * * In grazing the stock gather up more or less snow, which serves in great measure as a substitute for water. With the disappearance of snow in the spring, stock go up into the foothills, following the receding snow line. The grass which lies covered all winter is relished best. Besides, the young crop starts first and grows fastest among the steep hills.

What is here said of Buffalo Bunch-grass applies also to Montana and Idaho, where it grows at lower altitudes. This grass has received the same high appreciation by stockmen everywhere.

Buffalo-grass (*Bulbilis dactyloides* Raf.) (fig. 4) once extended farther east than now, since it is reported from northwest Iowa. I did not, however, meet with it in that part of the State, nor did I observe it east of Lincoln, Nebr. At Lincoln small patches occur. It is abundant about Hastings, Nebr., where, in some cases at least, it is the chief pasture grass. It is common about Oxford and

McCook, Nebr., and westward to the Nebraska line, although at no point was it so finely developed as on the beautiful prairies surrounding Hastings. Buffalo-grass is certainly adapted to the semiarid belt and to the western part of the humid prairie region. Farmers agree that it is exceedingly valuable, not only because of its nutritious qualities, but the close turf retains the moisture and allows the plant to develop under conditions adverse to most plants, certainly to our cultivated grasses. Every effort should be made to retain this grass. In central and southwestern Nebraska it is not only a valuable summer forage, but the mild winters make it especially desirable for winter grazing. When used for this purpose it should not be cropped too closely in the summer. The farmer should recognize the importance of not overstocking the ranges. He should give this and other grasses time to produce seed, so that they may perpetuate themselves by seeds from the most vigorous plants. Buffalo-grass seeds freely, and this is one of the most important points in its favor. In Colorado I observed it only in the lower foothills, where it is a valuable grass. It grows in the same way as on the plains, forming large mats and patches of turf, which are closely cropped by stock.

FIG. 4.—Buffalo-grass (*Bulbilis dactyloides*): *a*, female plant; *b*, male plant; *a'*, two clusters of female spikelets; *b'*, a branch of several staminate spikelets; *c*, a male or staminate spikelet of two flowers.

Buffalo Pea (*Astragalus caryocarpus* Ker.) is common on the prairies of Nebraska and dry, sterile hills of central and western Iowa. It is valuable as a forage plant.

Bunch-grass (*Sporobolus heterolepis* Gray) is the most valuable of the several Drop-seed grasses that abound in central and western Iowa. This beautiful species occurs on high or low prairies and hillsides with Little Blue-Stem and Switch-grass. It grows in bunches and produces large numbers of slender leaves close to the ground.

Bunch Spear-grass (*Poa arida* Vasey) comes up quite abundantly in the meadows of arid pastures in the Republican River Valley, Nebraska. It somewhat resembles Blue-grass, with sharp-pointed

leaves and a more scant growth. It flowers early, and hence when hay is cut it is past its season.

Bushy Blue-Stem (*Andropogon nutans* L.) is a tall perennial found in open woods and prairies in Iowa and eastern Nebraska, but is less common than the other blue-stems. It is cut late in the season, usually in August or September, because then more easily made into hay. The hay is palatable and nutritious, and cures well. Though the quantity would be less if cut by the middle of August, the quality would be superior.

FIG. 5.—Fresh-water Cord-grass (*Spartina cynosuroides*). *a*, spikelet showing three stamens; *b*, spikelet showing the projecting stigmas of the pistil; *c*, the same with the outer glumes removed.

California Oat-grass (*Danthonia californica*) is abundant in the pine woods and meadows of northern Colorado at an altitude of 8,000 feet. It grows in bunches from 1 to 3 feet high, has soft foliage, and is one of the valuable mountain grasses. It is much eaten by stock, and forms a considerable element in the forage of the mountain "parks" and meadows.

Colorado Blue-Stem (*Agropyron spicatum*) is one of the two valuable grasses of this genus that are native to Iowa. It is common on the loess in western Iowa, where it is used for both hay and pasturage. As an introduced plant it is now common at many points in central Iowa and is spreading rapidly. In Iowa it grows more vigorously than it does in Nebraska, where it attains a height from 2 to 4 feet. It is bluish green in color, with somewhat harsh leaves. The thriftiness of this grass in new meadows as well as in the vicinity of plowed ground indicates that an occasional stirring is beneficial. I am assured that it is not difficult to start a good meadow of this grass in two or three years on plowed ground. It

grows along with such grasses as grama and other prairie species. Meadows of considerable extent occur between Crete and Hastings, Nebr. It is quite a novelty to see hundreds of acres with the conspicuous blue-green color of this grass. It is common in the foothills in central and northern Colorado, and about Golden and Colorado Springs. It is not uncommon in open places at an altitude of 7,000 feet, but is much more abundant at 5,000 and 6,000 feet.

Cord-grass (*Spartina cynosuroides* Willd.) (fig. 5) is abundant in low grounds, and is an important feature of the meadows in western Iowa along the Missouri. It is well suited for the alluvial soils of this region, and can endure standing water better than Big Blue-Stem. Nature has adapted Cord-grass to low and swampy places. The reserve material stored in the root stocks enables it to grow rapidly when the water has receded. Many farmers hold this grass in high esteem. One farmer informed me that it was more valuable than Big Blue-Stem. For the Missouri River region it is a most profitable grass. In Nebraska it is common in low grounds from Omaha to McCook. It is of little value as a pasture grass, and is commonly cut for early hay.

Couch-grass (*Agropyron repens* Beauv.) is naturalized in many places in Iowa, and is often cut for hay. It starts early in the spring and produces a large number of fine leaves. In frequent rotations it is a pest rather than a valuable forage plant. In soils much subject to wash it has proved of value as a soil binder. It occurs as an introduced plant in Nebraska about Omaha and at McCook, but is much inferior to its western relative.

Crab-grass (*Panicum sanguinale* L.) is abundant throughout Iowa in cultivated fields and open places in blue-grass pastures. Usually regarded as a weed, but may afford some picking in cornfields after corn is removed. Under such conditions, however, the forage is of poor quality.

Downy Oat-grass (*Trisetum subspicatum*) is abundant in Colorado in dry open woods and open places. It is one of the first grasses to appear after fires have swept the forests.

Early Bunch-grass (*Eatonia obtusata*) grows in rather moist prairies throughout Nebraska. It matures early and produces only a small quantity of leaf and stem, and hence is not as important a factor in the production of either hay or green forage as is Prairie June-grass.

Feather Bunch-grass (*Stipa viridula* Trin.), although not indigenous to central Iowa, has been found spontaneous along the railroad west of Ames. It grows in bunches, seeds freely, and is much more palatable than Porcupine-grass. It might be introduced with advantage on the loess soils of western Iowa. In Nebraska it was observed in considerable quantity on the second bottom along the

Republican River and on the upland prairies. It is less objectionable on account of its "spears" than Porcupine-grass and Needle-grass. The leaves are softer and retain their nutritious qualities longer. It is well adapted to this section of Nebraska. In Colorado it is abundant, not only at an elevation of 5,000 feet in the vicinity of Fort Collins, but near Colorado Springs and Golden it abounds up to an altitude of 8,000 feet. It is one of the most valuable forage plants of the foothills.

FIG. 6.—Hungarian Brome-grass (*Bromus inermis*): *a*, spikelet; *b*, flowering glume seen from the back; *c*, floret seen from the anterior side, showing palea.

Fowl Meadow-grass (*Poa flava*) is not uncommon on the flats and along the smaller streams in western and northwestern Iowa. It would be of greater value for hay if it could be harvested earlier. Under present conditions of making hay in August it has lost much of its valuable qualities. In Colorado this species occurs in wet grounds at lower altitudes than Blue-grass.

Foxtail or **Pigeon-grasses** (*Chætochloa viridis* S. & S. and *C. glauca* S. & S.) are abundant throughout central and western Iowa in cultivated fields and in open places in Blue-grass pastures. Though usually regarded as weeds, they afford some picking in cornfields after the corn is removed. Under these conditions, however, the forage is of very poor quality.

Giant Rye-grass (*Elymus condensatus*) is abundant in Colorado, at an elevation of 5,000 to 5,500 feet. Cattle seem to prefer the shorter grasses to this large coarse species. Professor Lamson-Scribner speaks of it as an excellent winter forage plant in California. A second species (*Elymus triticoides*) was observed in spruce and pine woods in Clear Creek Canyon. It is of some value in the sparsely wooded areas of this region of Colorado.

Hungarian or **Smooth Brome** (*Bromus inermis* Leyss.) (fig. 6) withstands drought and cold, and is perfectly adapted to conditions existing in Iowa. It makes excellent growth and more nearly reaches the ideal of a farmer's grass than any other sort introduced in recent years. Under favorable conditions two crops can be cut in a single season, and the aftermath is excellent. Hungarian Brome commends itself to the farmers of central and western Iowa. This is the Russian grass or Russian Brome-grass of some writers.

Kentucky Blue-grass (*Poa pratensis* L.) (fig. 7) is the chief pasture grass of central and western Iowa, though not so prominent in northwestern Iowa. It does fully as well in and about Jefferson, Carroll, and Logan as in northeastern, southwestern, and southern Iowa. Southwestern Iowa has sometimes been called the Blue-grass region of the State. The spring of 1896 in central Iowa was early, and in many cases cattle were turned into the pastures before the 1st of May, from which time to the 15th of July this grass is generally at its best. Although checked by a short mid-summer drought, a vigorous growth was induced by rains in the latter part of July, so that during August and September pastures looked as green as they did in May. It is not uncommon for many farmers to feed in August, but the excellent condition of the grass pasture rendered this entirely unnecessary in 1896.

FIG. 7.—Kentucky Blue-grass (*Poa pratensis*): *a*, a spikelet; *b*, the floret, showing the hairs or wool at the base.

In 1895, and especially 1894, because of the great drought in Iowa, many farmers fed green corn fodder in August. Blue-grass can not, therefore, be depended on every season, but it is reliable and safe as a pasture grass most seasons. Green corn fodder is a safe sub-

stitute, and every farmer should have some corn which can be used to feed in July and August when necessary. Some farmers in central Iowa advocate the more extended use of corn fodder for this purpose. They believe that less area should be devoted to the grass pasture. A Blue-grass turf is a producer of wealth, and if properly managed increases in importance as the country becomes older. Short rotation is not advised, though many farmers get excellent results by planting Blue-grass seed in the cornfields. In the spring of 1895, and especially the fall of 1894, many farmers were disheartened because of the many vacant spots left in the pastures. These were soon occupied by Squirrel-tail grass, or Wild Barley, and Pepper-grass (*Lepidium apetalum* Willd.). These pastures have entirely recovered during the past season.

The subject of Blue-grass should not be passed without saying something of its use in the central section of the State as a winter forage plant. When speaking of winter pasturage in Iowa, the farmer refers to Blue-grass. It is a well-known fact that cattle do remarkably well on this grass in the winter. Though it has lost in nutritive qualities, it is highly relished and serves a most excellent purpose in keeping the digestive organs of the animal in good condition. With a good winter pasture of Blue-grass it will be unnecessary to use the "stock foods" to regulate the organs of secretion. Farmers should not lose sight of the fact that overstocking is injurious. To be in good condition for the winter it should not be overstocked in September and October. Other grasses have been tried in this way. Texas Blue-grass has received considerable notoriety in this respect, and while perfectly hardy at Ames, Iowa, nothing can be said about its use in central Iowa for this purpose, since it has not been extensively tried.

The composition of winter-grown and summer-grown Blue-grass, according to analyses made at the Iowa Experiment Station by Prof. G. E. Patrick and Mr. C. M. Wade, is as follows:

Analyses of winter-grown and summer-grown Blue-grass.

Constituents.	Winter-grown Blue-grass.		Spring and summer grown Blue-grass.		
	3 to 7 inches high, gathered Nov. 24, 1890.		3 to 6 inches high, gathered Apr. 28, 1890.	Early bloom, gathered July 28, 1890.	Just after bloom, gathered June 7, 1890.
	Green.	Dried.	Green.	Green.	Green.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Water	61.73	23.05	68.05	62.91	61.24
Dry substance	38.27	76.95	31.95	37.09	38.76
Dry substance:					
Ash	9.32	12.41	11.49	8.47	8.66
Fat	4.69	4.24	5.55	2.25	2.75
Nitrogen-free extract or carbohydrates	51.49	48.40	42.74	50.50	50.79
Fiber	19.61	26.56	22.19	29.11	29.92
Protein	14.89	8.39	18.03	9.67	7.88

In eastern Nebraska Blue-grass is a success, thriving best on low grounds along rivers, but also giving good returns on the drier uplands. The season of 1895 was unfavorable for it in central Nebraska, but in 1896 the pastures were in excellent condition. The species was observed at Hastings and McCook. In the latter place it occurred in the streets and also in the flood plain of the Republican River. One of the finest Blue-grass lawns I have ever seen was noticed in Oxford. This was, of course, under irrigation. In the mountains of Colorado it forms an excellent turf. The meadows were as green as any in Iowa in May.

Large Rush-grass (*Sporobolus hookeri* Trin.), which is found on poorer soil than Bunch-grass, forms a dense turf. The leaves and stems are tough and wiry, detracting from its value as a forage plant. *Sporobolus cryptandrus* Gray is an earlier grass, likewise somewhat tough when old, not so common as Bunch-grass or large Rush-grass. *Sporobolus brevifolius* is one of the commonest grasses of the loess of western Iowa. It forms a dense mat of interlacing roots and root stocks, effectually preventing the washing of the soils. It also occurs near Carroll, Iowa. The species is of little value as a forage plant. Another species of this genus is common throughout this section of Iowa—Southern Poverty-grass (*S. vaginæflorus*). It occurs in fields and along roadsides, and is usually avoided by stock. During the dry seasons of 1894 and 1895 farmers complained of its presence in pastures.

Little Blue-Stem (*Andropogon scoparius* Michx.) is common in central and western Iowa. It grows on the poorer sandy soils, although in western Iowa it occurs abundantly on the loess bluffs, constituting a large share of the natural forage. It has the habit of forming bunches, and grows from 2 to 3 feet high, with a large number of root and stem leaves. It seeds more freely than Big Blue-Stem. Stock will eat the grass when it is young and fresh, but when old it becomes woody and unpalatable. It is common on the loess of eastern Nebraska about Omaha, and was also observed about Lincoln and Crete.

Loco Weed (*Oxytropis lambertii*) is of no value as a forage plant. Although the plant was common everywhere in Nebraska, I heard no complaints about it. In Colorado it is the most conspicuous and common of the *Leguminosæ*, but it is seldom eaten by stock.

Lupinus plattensis Watson occurs in sandy bottoms along the Republican River in Nebraska. It showed evidence of having been eaten by stock.

Manna grasses (*Panicularia* species). Several species occur in Iowa. *P. nervata* and *P. aquatica* are most common. These species are of value only in wet meadows and pastures.

Meadow grasses (*Poa* species) are common throughout the mountains of Colorado. At higher altitudes and lower down in moist

canyons Wood Meadow-grass (*Poa nemoralis*) is abundant, as is Bunch Red-top (*Poa buckleyana* Nash). These species are not so valuable as *Poa wolfii* Scribner, which is common in dry woods in Clear Creek Canyon, where it is one of the more important grasses. *Poa lettermannii* is common above timber line on Pikes Peak. *Poa rupestris* is likewise common. These poas constitute some of the most valuable grasses in all of the mountain meadows. *Poa wheeleri* Vasey is another valuable grass of this genus found at an altitude of 7,800 feet. Mountain Spear-grass (*P. alpina*), at an altitude of 10,000 feet to timber line, forms a large cluster of leaves close to the ground.

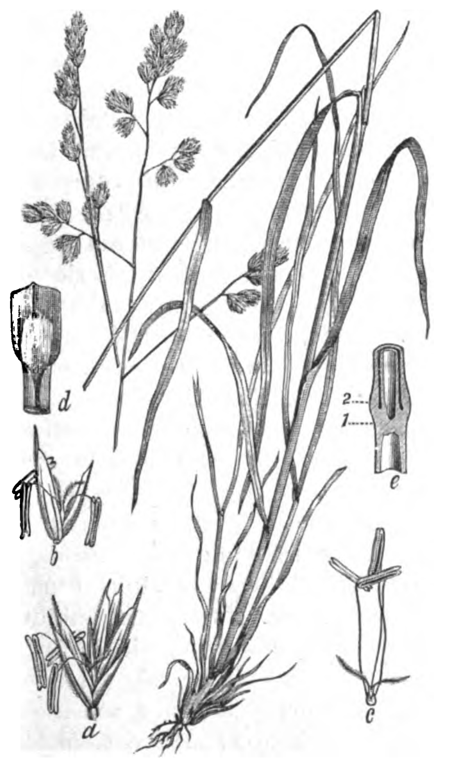

FIG. 8.—Orchard-grass (*Dactylis glomerata*): *a*, a spikelet with one of the florets expanded in flower; *b*, the floret; *c*, the flower, consisting of three stamens and pistil with two feathery stigmas; *d*, the upper portion of the leaf sheath and the lower portion of the leaf blade, showing ligule; *e*, section of the stem or culm at one of the nodes; 1, node proper; 2, the swelling enlargement of the basal portion of the leaf sheath.

Millets (*Chætochloa italica* and var. *germanica*). No other grasses are so productive on Iowa soil as the millets. Some farmers sow these grasses every year. As a rule, however, they are sown as "catch crops" in the latter part of June or early July, when by September a good crop of hay can be made. Some farmers are prejudiced against the millets because of the danger to stock when consuming large quantities of seed. When rightly managed, there need be little danger from this source. Millets are extensively grown in both eastern and western Nebraska. They do well in nearly all parts of the State. Fine fields were noted near Omaha, Crete, and Hastings, and also near McCook, at an altitude of 2,500 feet.

Needle-grass (*Stipa comata* Trin. & Rupr.) is common in Nebraska about McCook and westward, at an altitude of 2,500 to 3,000 feet. This grass grows on the high prairies. It is of forage value only under the same conditions as Porcupine-grass. In Colorado it is common in places in the foothills about Golden, Fort Collins, and Colorado Springs. It is not so valuable as Feather Bunch-grass, but adds to the list of plants available for forage purposes.

Orchard-grass (*Dactylis glomerata* L.) (fig. 8), though well known as a valuable grass, is seldom sown. Few farmers in this section of the State are acquainted with it. It is not uncommon along roadsides and in dooryards, giving evidence of adaptability to soil and climate. Although not generally cultivated in Nebraska, it is of frequent occurrence about Omaha, Lincoln, Crete, Hastings, and McCook. In all of these places it grows without irrigation, and the fact that it grows so well certainly indicates adaptation. Orchard grass is not, however, to be recommended for western Nebraska except in canyons and on the flood plains of streams. In eastern Nebraska it should come into general favor.

Porcupine-grass (*Stipa spartea* Trin.) is as common on the dry, sterile hills of central Iowa as it is in western Iowa. It has the habit of growing in large bunches, from 1½ to 3½ feet high, with leaves often more than a foot long. It is useful as a pasture plant only early in the season or when kept closely cropped. It is often troublesome after the 10th of June, since the barbed "seed" is then either forming or ripe, and is liable to inflict injury to sheep. The danger from this has become less in recent years, as the grass rarely regains its hold upon cultivated soil. After the "spears" have fallen the grass may be cut for hay. In Nebraska it is common only in the eastern part, occurring on high prairies and the slopes of hills. Although regarded as a pest in pastures, it is valued as a hay grass.

FIG. 9.—Prairie June-grass (*Koeleria cristata*): *a*, empty glumes; *b*, the two florets raised above the empty glumes.

Prairie June-grass (*Koeleria cristata* Pers.) (fig. 9) grows abundantly on the prairies and dry hills of Nebraska and Iowa. It comes on early and retains its nutritious qualities even after the leaves become dry. It is common about Omaha, Crete, and McCook. In Colorado

it is one of the most abundant of the grasses in dry places in the foothills. Great quantities of it were observed near Fort Collins and Golden and at Colorado Springs, at an altitude of 7,000 to 8,000 feet. It was closely cropped, showing evidences of being relished by stock. Though an insignificant grass, so far as bulk is concerned it is one of the more valuable species of the foothills.

Red Clover (*Trifolium pratense*) is the chief leguminous forage plant of central and western Iowa. It is not quite as successful in the northwestern part of the State as further east, yet fine fields were observed near Sioux City the past season. Farmers sow the seed in early spring, either with or without a nurse crop. Nearly every farmer has his clover patch. It is used as a fertilizer as well as a hay crop. The first crop is cut for hay, while the second is often used for seed. It is a common practice to pasture after hay has been removed.

Red-Top (*Agrostis alba*) grows wild in low grounds, although it is seldom sown. It makes excellent hay, but as yet is not much of a factor in the forage of the State. It is a valuable grass in eastern Nebraska, especially in low ground, where it has been tried by many of the farmers, and is more common, as a naturalized plant, than Orchard-grass. It was observed in western Nebraska about McCook, in the Republican Valley, where it seems to be a most valuable addition.

Reed Canary-grass (*Phalaris arundinacea*) is more common and of greater value as a native forage plant under present conditions than Wild-Rice or Reed-grass. It matures early, produces a large number of bright green leaves that may be used with considerable advantage for hay in June. The soil in which it grows is often so wet, however, that the stock obtain it with considerable difficulty. The leaves remain green for some time after the seed has formed. It is common near Jefferson, Council Bluffs, Missouri Valley, and Sioux City, Iowa.

Reed-grass (*Phragmites vulgaris*) was once abundant and is still common in western and central Iowa, about old lake beds and marshes. It is of little value as a forage plant. In Nebraska it is common in very wet marshes along streams. Specimens from 12 to 14 feet high were observed near McCook.

Rye (*Secale cereale*). Farmers do not fully appreciate the great value of rye as a forage plant. It is used to a large extent and fully meets the requirements for fall, winter, and early spring pasturage. It is usually sown in the fall, and as soon as it is 4 or 5 inches high it will stand a moderate amount of grazing, which can be kept up through the winter and early spring. In the spring it affords a greater abundance of pasture than Blue-grass. Farmers who have used it commend it most highly for this purpose. One farmer complained that butter acquired a peculiar taste when the cows were fed on rye, but that was probably due to some other cause.

Sheep's Fescue (*Festuca ovina* L.). Several forms occur in the foothills of Colorado. On the steep sides of rough and rocky mountains it grows in small bunches with numerous firm leaves. Here it is a most valuable grass.

Short-awned Brome (*Bromus breviaristatus* Thurb.) (fig. 10) has been introduced and grown for a number of years in central and western Iowa. The results have been very satisfactory. Two crops may, under favorable conditions, be cut in a single season. It is nearly as valuable as Hungarian Brome, and is worthy of a more extended trial. In Colorado it is common in some gulches in the vicinity of Fort Collins at an altitude of 6,000 feet, and is equal in point of vigor to Hungarian Brome-grass. It produces an abundance of large, soft leaves, and the forage is well liked by stock.

FIG. 10.—Short-awned Brome-grass (*Bromus breviaristatus*): *a*, the floret seen from the side; *b*, palea; *c*, joint of the rachilla; *d*, grain; *f*, young seed or grain; *e*, lower portion of pistil, showing lodicules.

Side Oats Grama or **Tall Grama** (*Bouteloua curtipendula*) (fig. 11) is common on hills in central and western Iowa. It is a valuable grass of the loess, occurring abundantly on rather dry soils. The hay made from it is of the very best quality. It cures readily, and even when cut late in the season the leaves retain their freshness longer than many other wild grasses. It occurs throughout Nebraska, but was apparently most abundant in the eastern half of the State. It makes a fine growth of leaves, and is highly prized by farmers for hay and grazing.

Sleepy-grass (*Stipa robusta* Scribn.) is common at altitudes of from 5,000 to 5,500 feet, growing in large patches. Although cattle are numerous everywhere in this region, they apparently do not touch this grass. It flowers much later than Feather Bunch-grass (*Stipa viridula*).

Slender-Fescue (*Festuca octoflora* Walt.) was observed not only in the foothills about Fort Collins, but also at Golden and Colorado Springs, Colo., from 5,000 to 9,000 feet. It is an annual, and in dry soil rarely attains a height of more than 4 inches, but in more sheltered and moister places it reaches a foot in height. This grass is at best of little value as a forage plant.

Slender Wheat-grass (*Agropyron tenerum* Vasey), mentioned as occurring along irrigation ditches throughout northern and central Colorado, is a valuable mountain grass. It grows in marshy meadows, attaining a height of 4 feet, with a large number of soft leaves and a long slender spike. It adds much to the forage of these mountain meadows, and would be far preferable to barley as a productive crop.

FIG. 11.—Side Oats Grama (*Bouteloua curtipendula*): *a*, one of the short spikes; *b*, a spikelet; *c*, a spikelet with the outer empty glumes removed.

Squirrel-tail grass (*Hordeum jubatum* L.) is common in Iowa and Nebraska, but it may be questioned whether it should be included among the forage grasses. It grows everywhere in meadows and pastures throughout the State. Squirrel-tail grass affords some pasturage early in the spring and in the fall, when the young plants come up abundantly after the rains. If allowed to head out, it soon becomes a troublesome pest.

Swamp-Chess (*Bromus ciliatus*) is of frequent occurrence in Iowa. The variety *purgans* matures its seed in June or early July, and occurs chiefly in woodland pastures where it is of considerable value. It is not as vigorous or as large a grass as the species, which matures in August. The latter has large culms and panicles with an abundance of leaves. This chess is certainly valuable for Iowa. It also occurs in eastern Nebraska, chiefly in woods and low

meadows, where it affords considerable forage, and seems worthy of a trial under cultivation. In Colorado the variety *purgans* is one of the most common of this genus at an altitude 6,000 to 7,000 feet about Golden. It is especially common in pine and spruce woods. It grows as vigorously at this altitude as in Iowa.

Switch-grass (*Panicum virgatum* L.) is common and productive everywhere in central and western Iowa. It grows abundantly in native prairie sod and along railroads. It is by no means confined to the bottom land or the richer prairie soil, being frequently found on sandy or gravelly drift, but it affords more and better forage on the richer soil. It is used for both hay and pasturage, but is of much less value as a pasture grass than for hay. It has been tried in a small way under cultivation in central Iowa, with promising results. The trials have not been extended enough, however, to recommend it for general culture. In eastern Nebraska it is abundant on the prairies, river bottoms, and open wooded slopes, and it was observed as far west as McCook, where the common form had a bluish color.

Tall Oat-grass (*Arrhenatherum elatius* Beauv.) has been tried in Iowa, and although it stands drought and cold well and makes a good growth, it has not come into general cultivation.

Texas Crab-grass (*Schedonnardus paniculatus* Trelease) is a common species in western Nebraska, and also occurs near Lincoln and Crete. About Hastings, Oxford, and McCook it is abundant on the high prairies. It is also abundant in the sandy flood plains of the Republican Valley. Cattle apparently seldom eat it, except when the grass is young and tender.

Timothy (*Phleum pratense* L.) is the best known of our hay grasses. It is used but little as a pasture grass. The bulbous thickening of the rootstock is apt to be pulled out by cattle or injured by tramping. Farmers generally use it as a meadow grass, sowing it in early spring either with or without a nurse crop or with Red Clover. In the latter case the clover predominates the first season, but in the second and third seasons the timothy is more abundant and less rank than when grown by itself. Hay consisting of this mixture is excellent and is generally preferred to any other. Timothy is well adapted to eastern Nebraska, where it succeeds better on low grounds than on the higher prairies. I saw very fine fields in 1896. Timothy is one of the best known of the cultivated grasses of eastern Nebraska, and is fully as much at home here as in western Iowa. In Colorado it is frequent as an introduced grass in moist gulches and canyons at an elevation of from 5,000 to 7,000 feet. It also grows at a higher altitude, though not so common there. Mountain timothy (*Phleum alpinum*) grows in moist woods and marshes at higher elevations in northern Colorado, from 8,000 to 10,000 feet. Where cattle grazed this grass was closely cropped, and was of considerable value as a forage plant.

Triple-awned Beard-grass (*Aristida fasciculata* Torrey) grows in dry places between Omaha and Lincoln, Nebr., but west of Lincoln it becomes very common. This grass is of value only when young, as the stems and leaves soon become wiry and harsh. Though not considered of much value on the plains, it is not without merit in the foothills. It grows in small bunches, having numerous fine leaves.

Turkey-foot-grass (*Andropogon hallii* Hack.) (fig. 12) was observed only in the sandhill region of western Nebraska. Here it produces an exuberant growth, 4 to 6 feet high, with a large number of leaves. It should be cut early if used for hay. Cattle are fond of the grass when young and fatten on it. Many farmers believe that for range purposes the sandhills are much superior to the country east, and Turkey-foot is one of the most important grasses of the region.

FIG. 12.—Turkey-foot-grass (*Andropogon hallii*): *a*, a pair of spikelets; *b*, the first empty glume of the sessile spikelet; *c*, second empty glume; *d*, the third glume; *e*, fourth or flowering glume; *f*, palea showing a pistil and lodicules.

Western Brome grass (*Bromus pumpellianus*) occurs in large patches, at an altitude of 9,500 to 10,000 feet. It is a striking green grass from 2 to 3 feet high, and forms a splendid turf. For cooler regions and in moist places this would no doubt prove valuable under cultivation.

White Clover (*Trifolium repens*) is a fickle plant in Iowa. An abundance of moisture is essential for its full development. When this condition is fulfilled it affords fine pasturage. Very few farmers ever sow white clover. In 1894 and 1895 it was not abundant, but in 1896 the Blue-grass meadows were white with it in June. It has been suggested that the winters are too severe and the plants are killed. Periodical scarcity of white clover is more than likely

to be associated with diminished seed production, caused by dry weather. The plant blossoms freely during moist weather, attracting the honey-bees, its chief pollinators. Moist weather accelerates seed production, as well as vegetative growth.

Wild Rye (*Elymus canadensis*) is very abundant on the prairies, low flats, and along the smaller streams in both Iowa and Nebraska. On valley lands it sometimes makes up more than half the wild hay. The forage is excellent when cut in time, but it is of little value as cut here in ordinary practice. It is usually cut in August, when the dead spikes stand out conspicuously among Blue-stem. There is often great danger in using such hay, as it frequently contains ergot—as many as eight or nine ergotized grains having been observed in a single head. The only safe course to pursue is to cut the grass in July, before the ergot has formed. In favorable seasons the meadow will produce a good second crop, which can be used as autumn pasture.

Wild Vetch (*Hosackia purshiana* Benth.), a native legume on low prairies in Nebraska, is a most valuable plant and worthy of cultivation. It has established itself in central Iowa, and is not uncommon on the loess region along the Missouri.

Wire grass (*Poa compressa* L.) is frequent in dry woods and in sterile soils in Iowa, and under such conditions is a valuable plant, forming a dense and close turf. It was observed in eastern Nebraska in the vicinity of Omaha and also as far west as McCook, in Red Willow County, where it grows without irrigation. It thrives in drier places and poorer soils than Blue-grass. This grass is worthy of encouragement, for though less productive than Blue grass, it furnishes good forage where better grasses will not grow.

LIST OF GRASSES COLLECTED IN IOWA, NEBRASKA, AND COLORADO.

The accompanying list is based on specimens collected at the following points:

In Iowa: Jefferson, Carroll, Carnarvon, Sioux City, Logan, Missouri Valley, and Council Bluffs.

In Nebraska: Lincoln, Crete, Oxford, and McCook.

In Colorado: Fort Morgan, Greeley, Fort Collins, La Porte, and other points in Larimer County. Along the tributaries of the Cache la Poudre River, Denver, near the mouth of Clear Creek Canyon, Golden, Colorado Springs, and North Cheyenne Canyon.

The higher altitudes as here given are based on field observations. The altitudes of lower points are based on Henry Gannett's Dictionary of Altitudes, and are approximate only for these places.

ANDROPOGONEÆ.

Andropogon nutans avenaceus Hack.

Iowa: Carroll, altitude 1,240 feet; Carnarvon, altitude 1,200 feet; Missouri Valley, altitude 1,022 feet.

A. provincialis furcatus (Muhl.) Hack.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,200 feet; Carnarvon, altitude 1,200 feet.

Nebraska: McCook, altitude 2,517 feet.

A. scoparius Michx.

Iowa: Sioux City, altitude 1,230 feet; Carroll, altitude 1,240 feet; Missouri Valley, altitude 1,030 feet.

PANICEÆ.

Panicum capillare L.

Iowa: Missouri Valley, altitude 1,022 feet; Jefferson, altitude 1,118 feet; Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet.

Nebraska: Crete, altitude 1,364 feet.

Colorado: Colorado Springs, altitude 5,978 feet; Fort Collins, altitude 4,984 feet; fields and roadsides.

P. crus-galli L.

Iowa: Jefferson, altitude 1,118 feet, abundant in fields, gardens, and along roads.

Colorado: Fort Collins, altitude 4,984 feet, along irrigation ditches or in moist places.

P. crus-galli muticum Vasey.

Colorado: Fort Morgan, altitude 4,500 feet, moist places and sandy bottoms of Platte River.

P. glabrum Gaudin.

Iowa: Missouri Valley, altitude 1,015 to 1,025 feet; Sioux City, altitude 1,110 to 1,125 feet, not common.

P. proliferum Lam.

Iowa: Missouri Valley, altitude 1,022 feet; Council Bluffs, altitude 990 to 1,025 feet; Carroll, altitude 1,240 feet.

Nebraska: Lincoln, altitude 1,159 feet, fields and roadsides.

P. sanguinale Linn.

Iowa: Jefferson, altitude 1,118 feet: Council Bluffs, altitude 990 to 1,025 feet; Sioux City, altitude 1,122 feet; Carroll, altitude 1,240 feet.

Nebraska: Lincoln, altitude 1,159 feet.

P. scribnerianum Nash.

Iowa: Council Bluffs, altitude 990 to 1,025 feet, common.

Nebraska: Crete, altitude 1,364 to 1,400 feet, prairies.

P. virgatum L.

Iowa: Carrol, altitude 1,240 feet; Sioux City, altitude 1,122 feet, abundant.

Nebraska: McCook, altitude 2,517 feet, flood plains of Republican River and prairies.

Chætochloa glauca (L.) Scribn.

Iowa: Jefferson, altitude 1,118 feet; Council Bluffs, altitude 990 feet; Sioux City, altitude 1,122 feet; Carroll, altitude 1,240 feet.

C. italica (L.) Scribn.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet; Jefferson, altitude 1,118 feet.

Nebraska: Crete, altitude 1,364 feet, an escape from cultivation and spontaneous along railroads.

C. verticillata (L.) Scribn.

Iowa: Council Bluffs, altitude 1,025 feet, introduced.

C. viridis (L.) Scribn.

Iowa: Jefferson, altitude 1,118 feet; Council Bluffs, altitude 990 feet; Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet.

Nebraska: Crete, altitude 1,364 feet, a common weed.

Cenchrus tribuloides L.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,115 feet; Missouri Valley, altitude 1,015 to 1,028 feet; Council Bluffs, altitude 985 to 995 feet; abundant in Iowa along railroads where sand and gravel ballast are used, also in flood plains of streams.

Nebraska: McCook, altitude 2,517 feet, abundant; sandy flood plain of Republican River.

ORYZEÆ.

Homalocenchrus oryzoides (L.) Poll.

Iowa: Carroll, altitude 1,230 feet; Sioux City, altitude 1,115 feet; Jefferson, altitude 1,118 feet, abundant in low grounds.

H. virginicus (Willd.) Britt.

Iowa: Carroll, altitude 1,240 feet; Jefferson, altitude 1,118 feet; Sioux City, altitude 1,122 feet, frequent.

Nebraska: Crete, altitude 1,364 feet, in woods near streams.

PHALARIDEÆ.

Phalaris arundinacea L.

Iowa: Jefferson, altitude 1,118 feet; Sioux City, altitude 1,115 feet.

Colorado: Greeley, altitude 4,770 feet, low grounds along irrigation ditches.

Savastana odorata (L.) Scribn.

Colorado: Beaver Creek, Larimer County, altitude 8,500 feet.

AGROSTIDEÆ.

Aristida fasciculata Torr.

Nebraska : Lincoln, altitude 1,159 feet; McCook, altitude 2,517 feet; very common not only in flood plains of Republican River, near McCook, but on the adjacent hills.

Colorado: Denver, altitude 5,182 to 6,000 feet; Golden, altitude 5,691 to 6,000 feet; Mount Zion near Golden, altitude 7,500 feet; La Porte, altitude 5,000 feet; Fort Morgan. Abundant on the plains, as well as the sandy foothills near La Porte. At higher altitudes usually a short grass.

Stipa comata Trin. and Rupr.

Nebraska: McCook, altitude 2,507 feet.

Colorado: North Cheyenne Canyon near Colorado Springs, altitude 6,000 feet; Fort Collins, altitude 4,984 feet; Fort Morgan; La Porte, altitude 5 095 feet, dry soil, red sandstone.

Stipa pinnata neo-mexicana Thurb.

Colorado: La Porte, altitude 5,095 feet; rare in dry, red soil.

S. robusta Scribn.

Colorado: Long Gulch, Larimer County, altitude 7,800 feet; Bosworth Ranch, Larimer County, altitude 7,500 feet, abundant on flats in meadows; Beaver Creek, Larimer County, altitude 9,500 feet.

S. spartea Trin.

Iowa: Sioux City, altitude 1,122 feet; Jefferson, altitude 1,118 feet; Council Bluffs, altitude 990 to 1,000 feet; a common grass in Iowa; high, dry prairies and loess along the Missouri.

S. viridula Trin.

Nebraska: McCook, altitude 2,517 feet, flood plains of Republican River.

Colorado: Fort Collins, altitude 4,978 to 5,000 feet, high banks of irrigation ditches; Colorado Springs, altitude 5,978 feet.

Eriocoma cuspidata Nutt.

Colorado: Fort Morgan, Platte River, altitude 4,990 feet, sandy soil, second bottoms; east of Denver, sand hills, altitude 5,100 to 5,300 feet; La Porte, sand hills, red sandstone, altitude 5,095 feet.

Muhlenbergia gracilis Trin.

Colorado: Fort Collins, altitude 4,984 feet, dry prairies; Beaver Creek, Larimer County, altitude 9,500 to 10,000 feet, dry soil.

M. gracillima Torr.

Colorado: Colorado Springs, altitude 5,978 to 6,000 feet, grows in bunches, very dry soil.

M. mexicana Trin.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet; Missouri Valley, altitude 1,022 feet, along roadsides.

M. racemosa (Michx.) B. S. P.

Iowa: Missouri Valley, altitude 1,022 feet; Council Bluffs, altitude 1,000 feet; Jefferson, altitude 1,118 feet; Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet.

Nebraska: Crete, altitude 1,364 feet, moist prairies, abundant.

Phleum alpinum L.

Colorado: Happy Hollow, Larimer County, altitude 8,300 feet, low marshy grounds; Beaver Creek, Larimer County, altitude 9,000 to 10,000 feet, subalpine, in canyons and swamps, common.

P. pratense L.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet; Jefferson, altitude 1,118 feet; Missouri Valley; Logan.

Nebraska: McCook, altitude 2,517 feet, in moist grounds.

Colorado: Beaver Creek, Larimer County, altitude 9,100 feet, along trail, high grounds; trail above Beaver Creek, Larimer County, altitude 10,500 feet, with a strongly developed corm-like bulb. Timothy is common throughout the irrigated districts of northern Colorado.

Alopecurus geniculatus L.

Colorado: Long Gulch, Larimer County, bank of Little Beaver, altitude 8,500 feet, rooting in mud.

A. geniculatus fulvus (J. E. Smith) Scribn.

Colorado: South Branch Cache la Poudre River, Larimer County, altitude 7,975 feet, rooting in mud; Greeley, altitude 4,770 feet.

Sporobolus airoides Torr.

Colorado: Fort Collins, altitude 4,950 feet, near Cache la Poudre River; La Porte, Larimer County, altitude 5,095 feet, sandstone soil; Fort Morgan, altitude 4,500 feet.

S. asperifolius Thurb.

Colorado: La Porte, Larimer County, altitude 5,095 feet, red sandstone; Fort Morgan, altitude 4,500 feet, sandy second bottom of Platte River.

S. brevifolius (Nutt.) Scribn.

Iowa: Missouri Valley, altitude 1,022 feet; Carroll, altitude 1,250 feet; Sioux City, altitude 1,122 to 1,130 feet; Missouri Valley, altitude 1,025 to 1,030 feet; Council Bluffs, altitude 1,020 to 1,040 feet.

Colorado: North Cheyenne Canyon, near Colorado Springs, near mouth of canyon, dry soil, altitude 6,000 feet.

S. cryptandrus (Torr.) A. Gray.

Iowa: Missouri Valley, altitude 1,022 feet.

Nebraska: Crete, altitude 1,364 to 1,500 feet, dry hills; McCook, altitude 2,517 to 2,700 feet.

Colorado: Denver, plains, altitude 5,294 feet; Fort Morgan, altitude 4,500 feet.

S. depauperatus (Torr.) Scribn.

Colorado: La Porte, Larimer County, altitude 5,050 feet, sandy soil.

S. heterolepis A. Gray.

Iowa: Carroll, altitude 1,240 feet.

S. longifolius (Torr.) Wood.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet, prairies and loess.

Nebraska: Hastings, prairies.

S. vaginæflorus Vasey.

Iowa: Carroll, altitude 1,240 feet, roadsides, common; Sioux City, altitude 1,122 to 1,130 feet, common.

Agrostis alba L.

Iowa: Carroll, altitude 1,240 feet; Jefferson, altitude 1,118 feet; Logan, Council Bluffs, altitude 990 to 1,025 feet.

Nebraska: Crete, altitude 1,364 feet; McCook, altitude 2,517 feet, common in low grounds, along small streams, in pastures and meadows.

A. exarata Trin.

Colorado: La Porte, Larimer County; marsh near Cache la Poudre River, altitude 4,990 feet; Greeley, altitude 4,770 feet, irrigated flats; Beaver Creek, Larimer County, altitude 500 feet, in swamps.

A. scabra Willd.

Iowa: Sioux City, altitude 1,122 feet.

Colorado: Beaver Creek, Larimer County, altitude 9,100 feet, in woods of *Pinus murrayanus*, along trail.

Polypogon monspeliensis (L.) Desf.

Colorado: Fort Collins, altitude 4,954 feet, along irrigation ditches.

Calamagrostis canadensis (Michx.) Beauv.

Iowa: Jefferson, altitude 1,118 feet, low moist prairies and bottoms of small streams, common throughout western Iowa.

C. purpurascens R. Br.

Colorado: Beaver Creek, Larimer County, altitude 10,000 to 11,000 feet, in dry woods and open places; grows in large bunches.

Calamovilfa longifolia (Hook.) Scribn.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet.

Nebraska: McCook, altitude 2,517 feet, common loess bluffs along Missouri River.

AVENEÆ.

Deschampsia flexuosa (L.) Trin.

Colorado: North Cheyenne Canyon, near Colorado Springs, altitude 6,500 feet.

D. cæspitosa (L.) Beauv.

Colorado: Beaver Creek, Larimer County, altitude 9,800 to 11,000 feet, in low grounds and swamps; Long Gulch, altitude 7,775 feet.

Trisetum subspicatum Beauv.

Colorado: Mountain trail, Pikes Peak, altitude 11,720 feet; Beaver Creek, Larimer County, altitude 10,500 to 11,200 feet, abundant in woods and open places.

Avena fatua L.

Colorado: Fort Collins, altitude 4,978 to 5,000 feet; Denver, altitude 5,000 feet, weed in grain fields.

Danthonia intermedia Vasey.

Colorado: Beaver Creek, Larimer County, altitude 9,100 feet; Bosworth Ranch, altitude 7,500 feet, in open pine woods, abundant.

CHLORIDEÆ.

Spartina cynosuroides (L.) Willd.

Iowa: Carroll, altitude 1,230 feet; Sioux City, altitude 1,115 feet; Missouri Valley, altitude 1,015 feet, abundant, alluvial bottoms and sloughs.

Nebraska: McCook, marshes along Republican River, altitude 2,512 feet

S. gracilis Trin.

Nebraska: McCook, alkaline marshes of Republican River, altitude 2,512 feet.

Colorado: La Porte, Larimer County, marsh, altitude 5,100 feet.

Schedonnardus paniculatus (Nutt.) Trelease.

Nebraska: Lincoln, altitude 1,159 feet; Crete, altitude 1,364 feet, dry hills; Hastings, dry prairies; McCook, altitude 2,517 feet, second bench lands, flood plain Republican River and low hills.

Colorado: Greeley, altitude 4,779 feet, dry soil, plains.

Bouteloua curtipendula (Michx.) A. Gray.

Iowa: Carroll, altitude 1,240 feet: Sioux City, altitude 1,122 feet; Missouri Valley, altitude 1,022 feet; Logan, altitude 928 feet, high prairies and loess bluffs along the Missouri.

Nebraska: Crete, altitude 1,364 feet; McCook, altitude 2,517 feet.

B. oligostachya (Nutt.) Torr.

Nebraska: Lincoln, altitude 1,159 feet; Crete, altitude 1,364 feet; Hastings; Oxford, altitude 2,085 feet; McCook, altitude 2,517 feet, common, prairies, flood plain of the Republican River.

Colorado: Near Colorado Springs, altitude 5,978 feet; Denver, altitude 5,200 feet; Fort Collins, altitude 4,984 feet; Greeley, altitude 4,779 feet; Fort Morgan, altitude 4,500 feet; Stove Prairie, Larimer County, altitude 7,800 feet, not common.

Beckmannia erucaeformis (L.) Host.

Colorado: Fort Collins, altitude 4,980 feet; Greeley, altitude 4,770 feet.

Bulbilis dactyloides (Nutt.) Raf.

Nebraska: Lincoln, altitude 1,159 feet, local; Crete, altitude 1,364 feet, local; Hastings, abundant; McCook, altitude 2,517 feet, high hills and flood plains of Republican River.

Colorado: Fort Collins, altitude 4,984 feet, plains; Fort Morgan, altitude 4,500 feet, plains, and flood plain of Platte River.

FESTUCEÆ.

Munroa squarrosa (Nutt.) Torr.

Nebraska: McCook, altitude 2,517 feet, abundant, flood plain of Republican River.

Colorado: Denver, altitude 5,200 feet, high plains; Fort Morgan, altitude 4,500 feet, high plains; Golden, altitude 5,691 feet.

Phragmites vulgaris (Lam.) B. S. P.

Iowa: Sioux City, altitude 1,115 feet; Council Bluffs, altitude 990 feet, low grounds.

Nebraska: McCook, altitude 2,512 feet.

Colorado: Fort Collins, altitude 5,100 feet, marshes.

Redfieldia flexuosa (Thurb.) Vasey.

Colorado: Fort Morgan, altitude 4,500 feet, sandy bottoms of Platte River, common.

Eragrostis major Host.

Iowa: Jefferson, altitude 1,118 feet; Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet; Council Bluffs, altitude 990 to 1,000 feet, roadsides.

Nebraska: McCook, altitude 2,517 to 2,550 feet, roadsides.

E. pectinacea (Michx.) Steud.

Nebraska: Crete, altitude 1,364 feet; Lincoln, altitude 1,159 feet; McCook, altitude 2,517 feet.

E. purshii Schrad.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet; Council Bluffs, altitude 990 to 1,000 feet, common along roadsides.

E. hypnoides (Lam.) B. S. P.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,110 feet.

Eatonia obtusata (Michx.) A. Gray.

Iowa: Sioux City, altitude 1,122 feet.

Nebraska: McCook, altitude 2,517 to 2,550 feet, common, high prairies and in flood plain of Republican River.

Colorado: Fort Collins, altitude 4,984 feet.

E. pennsylvanica (D. C.) A. Gray.

Iowa: Jefferson, altitude 1,110 feet; Sioux City, altitude 1,122 feet; Council Bluffs, altitude 995 feet, low flood plain of rivers.

Kœleria cristata (L.) Pers.

Iowa: Jefferson, altitude 1,118 feet; Sioux City, altitude 1,122 feet; Logan, high prairies and loess bluffs along the Missouri.

Nebraska: McCook, altitude 2,517 feet.

Colorado: Foothills near Golden, altitude 7,500 feet; La Porte, altitude 5,095 feet, red sandstone hills; Long Gulch, Larimer County, altitude 7,775 feet, dry places, common.

Catabrosa aquatica (L.) Beauv.

Colorado: Fort Collins, altitude 4,984 feet, in seepage water from irrigation ditches; in gulch west of Fort Collins, altitude 5,500 feet, abundant in water.

Distichlis spicata (L.) Greene.

Nebraska: Lincoln, altitude 1,159 feet, salt marsh; McCook, altitude 2,517 feet, salt marsh, flood plain Republican River, base of hills.

Colorado: Denver, altitude 5,200 feet, in vacant lots.

Dactylis glomerata L.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet, common.

Nebraska: McCook, altitude 2,517 feet, not common.

Colorado: Golden, altitude 5,691 feet.

Poa arctica R. Br.

Colorado: Above Beaver Creek, Larimer County, at snow bank, altitude 10,000 feet; swamp, Beaver Creek Canyon, altitude 9,500 feet.

P. arida Vasey.

Nebraska: McCook, altitude 2,517 feet.

Colorado: Fort Collins, altitude 4,484 feet, in dry soil, plains; La Porte, altitude 5,500 feet; above Beaver Creek, Larimer County, altitude 10,000 feet, dry places.

P. buckleyana Nash.

Colorado: Beaver Creek, Larimer County, altitude, 9,100 feet; Golden; Mount Zion, altitude 7,500 to 8,000 feet; also in Clear Creek Canyon, altitude 7,500 feet, open grounds.

P. coloradoensis Vasey.

Colorado: Rists Canyon, altitude 6,500 feet.

P. compressa L.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet, dry banks along railroads.

Nebraska: Crete, altitude 1,364 feet, dry banks; McCook, altitude 2,517 feet.

Colorado: North Cheyenne Canyon, Colorado Springs, altitude 6,000 feet, in open grounds.

P. epilis Scribn.

Colorado: Above Beaver Creek, Larimer County, timber line, altitude 11,000 feet, also at snow bank, altitude 10,000 feet; and swamps, Beaver Creek Canyon, between 9,800 and 10,000 feet.

P. fendleriana Steud.

Colorado: Little Beaver, Larimer County, 9,100 feet; Beaver Creek Canyon, altitude 10,500 feet; south fork Cache la Poudre, Larimer County, altitude 8,500 feet.

P. flava L.

Colorado: Fort Collins, altitude 4,978 feet, low grounds near river; Greeley, altitude 4,779 feet, low grounds.

P. lucida Vasey.

Colorado: Golden, Clear Creek Canyon, altitude 7,500 feet.

P. lettermani Vasey.

Colorado: Pikes Peak, altitude 14,147 feet; timber line, altitude 11,700 to 13,600 feet, common and conspicuous among other grasses.

P. nemoralis L.

Colorado: Golden, Clear Creek Canyon; Mount Zion, altitude 6,500 to 7,500 feet; North Cheyenne Canyon, near Colorado Springs; mountain trail, Pikes Peak, altitude 11,000 feet; Fort Collins, altitude 4,950 feet, irrigated flats; in gulch west of Fort Collins, altitude 5,500 feet; above Beaver Creek, Larimer County, altitude 9,000 to 10,000 feet; Happy Hollow, Larimer County, altitude 7,900 feet; Rists Canyon, altitude 6,665 feet, common in the mountains in moist places.

P. pratensis L.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet.

Nebraska: Hastings; McCook, altitude 2,517 feet, in moist places.

Colorado: Colorado Springs, altitude 5,978 to 6,000 feet; Fort Collins, irrigated fields, altitude 4,978 feet; Bosworths Ranch, Larimer County, altitude 7,500 feet; Poverty Flats, Larimer County, altitude 7,800 feet, open, dry flats, grass much reduced in size; Happy Hollow, Larimer County, altitude 7,900 feet.

P. rupestris Vasey.

Colorado: Mountain trail, Pikes Peak, altitude 11,500 feet; above timber line, altitude 12,500 feet; above Beaver Creek, Larimer County, altitude 9,000 to 10,000 feet, in swamps.

P. tracyi Vasey.

Colorado: Fort Collins, gulch west of Pennock, altitude 5,500 feet, in lower places.

P. wheeleri Vasey.

Colorado: Beaver Creek, Larimer County, altitude 9,100 feet.

Puccinellia airoides (Nutt.) Wats. & Coult.

Colorado: Fort Collins, altitude 4,950 feet, near river; Greeley, altitude 4,770 feet, low grounds.

Panicularia nervata (Willd.) Kuntze.

Colorado: North Cheyenne Canyon, near Colorado Springs, altitude 8,000 feet, edges of brooks.

Festuca arizonica Vasey.

Colorado: Beaver Creek, Larimer County, altitude 9,100 to 9,500 feet, dry open places; Rists Canyon, altitude 6,500 feet, a stout harsh grass.

F. brevifolia R. Br.

Colorado: Beaver Creek, Larimer County, altitude 9,800 feet, dry sterile soil.

F. kingii (S. Wats.) Scribn.

Colorado: Little South Cache la Poudre, Larimer County, altitude 8,700 feet; Beaver Creek, Larimer County, altitude 9,500 feet.

F. ovina L.

Colorado: Mountain trail, Pikes Peak, altitude 11,000 feet (a form of); Beaver Creek, Larimer County, altitude 9,000 feet, dry soil; Happy Hollow, Larimer County, altitude 7,900 feet; Poverty Flats, Larimer County, altitude 8,020 feet.

F. octoflora Walt.
Iowa: Sioux City, altitude 1,122 feet.
Nebraska: Crete, altitude 1,364 feet; McCook, altitude 2,517 feet.
Colorado: Golden, altitude 5,691 feet; Mount Zion, near Golden, altitude 7,500 feet; Denver, altitude 5,294 feet, dry soil; common at all the above points.

Bromus breviaristatus Buckl.
Colorado: Fort Collins; gulch west of Pennock, Larimer County, altitude 5,500 feet, in moist soil.

B. ciliatus L.
Iowa: Sioux City, altitude 1,122 feet.
Colorado: Beaver Creek, Larimer County, altitude 9,100 to 9,800 feet, in rather dry woods.

B. ciliatus purgans A. Gray.
Colorado: Clear Creek Canyon, near Golden, altitude 7,000 feet, in spruce woods.

B. inermis Leyss.
Colorado: Fort Collins, altitude 4,974 feet, escaped from cultivation, College farm.

B. kalmii A. Gray.
Colorado: Stove Prairie, Larimer County, altitude 7,800 feet, dry open woods.

B. pumpellianus Scribn.
Colorado: Beaver Creek, Larimer County, altitude 9,500 feet.

B. tectorum L.
Colorado: Fort Collins, altitude 4,974 feet, escaped from cultivation, common station grounds, College farm.

B. unioloides HBK.
Colorado: Fort Collins, altitude 4,974 feet, escaped from cultivation, College farm.

HORDEÆ.

Agropyron dasystachyum subvillosum Scribn. and Smith.
Colorado: Bosworth ranch, Larimer County, altitude 7,500 feet, low meadows.

A. divergens Nees.
Colorado: Golden, altitude 5,691 feet, open low places; Clear Creek Canyon, altitude 6,500 to 7,000 feet; Beaver Creek, Larimer County, altitude 9,500 feet, swamp; Long Gulch, altitude 7,800 feet, low places.

A. divergens tenuispicum Scribn. and Smith.
Colorado: Happy Hollow, altitude 7,500 feet, low grounds.

A. pseudorepens Scribn. and Smith.
Colorado: Bosworth ranch, Larimer County, altitude 7,200 feet, in open woods.

A. repens (L.) Beauv.
Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet.
Nebraska: McCook, altitude 2,517 feet, introduced.

A. richardsoni Schrad.
Colorado: Stove Prairie, Larimer County, altitude 8,000 feet, in open, dry soil.

A. scribneri Vasey.
Colorado: Beaver Creek, Larimer County, at timber line, altitude 11,000 feet.

A. spicatum (Pursh) Scribn. and Smith.
Iowa: Sioux City, altitude 1,122 feet, loess soil, common.
Nebraska: Lincoln, altitude 1,159 feet; Crete, altitude 1,364 feet; Oxford, altitude 2,085 feet; McCook, altitude 2,517 feet; abundant, prairies.
Colorado: Fort Morgan, altitude 4,500 feet.

A. tenerum Vasey.
Colorado: Colorado Springs, altitude 5,978 feet; Fort Collins, altitude 4,970 feet, along irrigation ditches; Greeley, altitude 4,779 feet, along irrigation ditches.

Hordeum jubatum L.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,123 feet; Council Bluffs, altitude 990 to 1,000 feet; Logan, altitude 928 feet; Jefferson, altitude 1,100 feet; abundant weed in meadows, pastures along roadsides, and along railroads.

Nebraska: Hastings, along railroads; McCook, altitude 2,517 feet, along railroads, sandy bottoms of Republican River.

Colorado: Fort Morgan, altitude 4,500 feet; Fort Collins, altitude 4,978 feet; along railroads, seepage swamps, and flats, abundant.

H. pusillum Nutt.

Iowa: Council Bluffs, altitude 1,000 feet, introduced.

Nebraska: Crete, altitude 1,364 feet; Hastings, along railroads, dry prairie soil; McCook, altitude 2,517 feet, along railroads and prairies.

Colorado: Denver, altitude 5,294 feet, prairies; Fort Collins, altitude 4,978 feet.

Elymus canadensis L.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet, loess bluffs; Jefferson, altitude 1,118 feet; Logan.

Nebraska: Lincoln, altitude 1,159 feet; Crete, altitude 1,364 feet, dry prairies, along railroads; McCook, altitude 2,517 feet, flood plains of Republican River.

Colorado: Fort Collins, altitude 4,984 feet, along railroads; Colorado Springs, altitude 5,978 feet; Rists Canyon, Larimer County, altitude 6,500 feet, dry open places.

E. glaucus Buckley.

Nebraska: McCook, altitude 2,517 feet, dry places, flood plains Republican River.

E. macounii Vasey.

Colorado: Greeley, altitude 4,770 feet, river bottoms; Fort Collins, altitude 4,900 feet, flats, Cache la Poudre River, common. The species has also been found near Jewell Junction, Iowa (Carver), in what was once an old lake bed.

E. nitidus Vasey.

Colorado: Near Golden, Clear Creek Canyon, altitude 6,000 to 7,000 feet, in yellow pine woods.

E. robustus Scribn. and Smith.

Iowa: Carroll, altitude 1,240 feet.

E. striatus Willd.

Iowa: Carroll, altitude 1,240 feet; Sioux City, altitude 1,122 feet; Jefferson, altitude 1,118 feet; Council Bluffs, altitude 990 feet.

E. triticoides Buckl.

Colorado: Near Golden, Clear Creek Canyon, altitude 7,500 feet, in woods.

E. virginicus L.

Iowa: Jefferson, altitude 1,118 feet; Sioux City, altitude 1,122 feet; Council Bluffs, altitude 990 feet; Logan, altitude 928 feet; Missouri Valley, altitude 1,022 feet.

Sitanion elymoides Raf.

Nebraska: McCook, altitude 2,517 feet, abundant, flood plains Republican River.

Colorado: Denver, altitude 5,294 feet, abundant, dry plains; Golden, altitude 7,000 feet; Mount Zion, near Golden, altitude 7,500 feet; Colorado Springs, altitude 5,978 feet; North Cheyenne Canyon, near Colorado Springs, altitude 6,500 feet; Fort Morgan, altitude 4,500 feet.

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BULLETIN No. 12. Agros. 31.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

A REPORT

UPON THE

GRASSES AND FORAGE PLANTS

AND

FORAGE CONDITIONS

OF THE

EASTERN ROCKY MOUNTAIN REGION.

BY

THOMAS A. WILLIAMS,
ASSISTANT AGROSTOLOGIST.

PREPARED UNDER THE DIRECTION OF THE AGROSTOLOGIST.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1898.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF AGROSTOLOGY,
Washington, D. C., April 23, 1898.

SIR: I have the honor to transmit herewith, and recommend for publication as Bulletin No. 12 of this Division, a report upon the grasses and forage plants and forage conditions of the eastern Rocky Mountain region, by Thomas A. Williams, assistant agrostologist. Field agents of the division have been carrying on investigations in the region embraced in this report during the past three years, and Mr. Williams, of the division staff, has visited, during the seasons of 1896 and 1897, the more important grazing districts, where, under the direction of the Agrostologist, he has studied the present forage problems of the region and investigated the native grasses and forage plants, noting their characteristics, distribution, general prevalence, and economic importance; he has endeavored to ascertain how the most desirable sorts may be preserved or increased, and has also made close personal observations with the view of determining some practical means of restoring the ranges to their original grazing value, or at least preserving them from further injury through careless and short-sighted practices. The present report is based upon these studies and investigations, as well as upon the results of work done by the field agents of the division. While carrying on these investigations the work of the field agents has not been confined to the districts easily accessible from the railroads and other common lines of travel, but, by means of wagon trips and side excursions on horseback, they have penetrated into the less-known localities, in every case making extensive collections of specimens and seeds, as well as obtaining all the data possible relating to the question of forage supply. One field agent thus covered nearly 1,000 miles in a wagon trip of two months during the past season. (See fig. 1.) There has also been included much valuable information acquired through correspondence with prominent citizens and leading stockmen, who have most cordially responded to letters of inquiry relative to the matters in question and materially aided the Department in the prosecution of these grass and forage-plant investigations. Hearty thanks are here expressed to all those correspondents who have thus cooperated in the work of the division.

Some idea of the importance of the subject of this Report upon the Grasses and Forage Plants and Forage Conditions of the Eastern Rocky Mountain Region is indicated by the following statements:

It is estimated from Report No. 7, Division of Statistics, that in the State of Wyoming about 15,000,000 acres are taken up by mountains and forest areas, about 10,000,000 acres are irrigable and hence suitable for general agriculture, while nearly 40,000,000 acres, or almost two-thirds of the entire State, may be regarded as pasture lands only. In Montana the proportion of pasture lands is fully as great as in Wyoming, while in Colorado it will probably fall but little below.

At the beginning of the year 1897 there were in these three States about 350,000 head of horses and mules, valued at about $9,000,000, over 3,000,000 head of cattle, valued at nearly $56,000,000, and over 6,200,000 head of sheep, valued at over $10,500,000, or a total valuation for the stock supported chiefly by these native pasture and meadow lands of about $75,500,000.

The first report on the investigations of the forage plants of the Northwest, from this division, was Bulletin No. 5, on the Grasses and Forage Plants of the Rocky Mountain Region, by P. A. Rydberg and C. L. Shear. This was followed by Bulletin No. 6, on the Grasses and Forage Plants of the Dakotas, by T. A. Williams, aided by Prof. M. A. Brannon, of North Dakota, and E. N. Wilcox and David Griffiths, of South Dakota. Embracing much the same field is Prof. L. H. Pammel's Notes on the Grasses and Forage Plants of Iowa, Nebraska, and Colorado, published as Bulletin No. 9 of this Division; and another, on The Red Desert of Wyoming and its Forage Resources, by Prof. Aven Nelson, is now in press. In the present bulletin the topographical features of the region are considered, including a discussion of the soil, water supply, etc. This is followed by detailed accounts of the cultivated grasses and forage plants and the more important forage plants, both grasses and species of other families, native to the region, concluding with suggestions on methods of improvement of the forage conditions of the ranges.

Respectfully,

F. LAMSON-SCRIBNER,
Agrostologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

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A REPORT UPON THE GRASSES AND FORAGE PLANTS AND FORAGE CONDITIONS OF THE EASTERN ROCKY MOUNTAIN REGION.

INTRODUCTION.

Stock raising will always be an important industry in the vast expanse of territory lying between the Rocky Mountains and the one-hundredth meridian. The early settlers recognized its many natural advantages for this purpose, and at once began to cover the hills and valleys with cattle and other stock. Under the stimulating influence of high prices, resulting largely from the demand created by the civil war, stock raising rapidly grew to be an industry of immense proportions. At first forage was plentiful; everywhere the supply seemed inexhaustible, and the ranchman's chief concern was to get more stock in order that he might turn into cash the grasses of the prairies. Stock grew and fattened on no other feed than the native grasses throughout the entire year.

At length, however, stockmen became aware of the fact that not only was there a possibility, but a probability, that the supply of forage would soon be exhausted if they continued to follow the old methods of stock raising. Under this old system of mismanagement the ranges were stocked to their utmost capacity, even for the most favorable conditions, and consequently the past series of dry seasons resulted in a great shortage of feed. Ranchmen are already confronted with the necessity of providing extra forage supplies for use in seasons when the grasses on the range are short.

With a view to finding some practical means of bettering existing conditions and encouraging stockmen in their efforts to grow forage crops, a series of investigations of the various forage problems existing in the West and Northwest, particularly in the States of Montana, Wyoming, and Colorado, is being carried on by the direction of the Secretary of Agriculture through the Division of Agrostology. These investigations are designed to secure full and accurate information regarding the present condition of the forage problem; what the greatest needs are, and how they can be met in the most practical manner; to study the native grasses and forage plants, their characteristics, distribution, abundance, and value; to ascertain the best means of preserving the more desirable sorts, and to introduce into cultivation such as promise to be of value; to devise some practical treatment for the

ranges which will not only restore their original grazing value but guard against future injury through overstocking and other careless and shortsighted practices.

The information upon which this report is based has been gathered from various sources. During the past three seasons field agents of the division have been working in the different parts of the region in question studying matters pertaining to the forage supply. The writer has made two trips into the more important grazing districts, and, under the direction of the chief of the division, has studied the conditions and needs by consulting with the stockmen and collecting all facts likely to aid in the work of getting at a practical solution of the

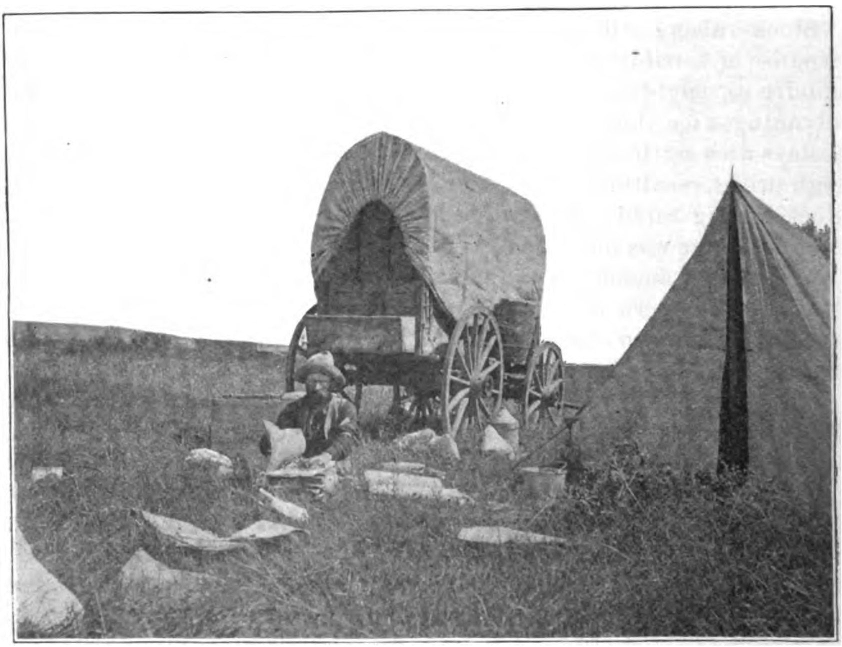

Fig. 1.—In the field.

various forage problems confronting the people at the present time, and thereby laying the foundations for more intelligent and economical practices in the future.

In April, 1897, the following circular letter with the appended questions was sent to prominent stockmen, farmers, and others interested in the forage problem:

United States Department of Agriculture,
Division of Agrostology,
Washington, D. C., April, 1897.

Dear Sir: Under the direction of the Secretary of Agriculture this division is investigating the forage question in the Northwest, particularly in the States of Montana, Colorado, and Wyoming. In this investigation particular attention is being given to the native grasses and forage plants, their characteristics, distribu-

tion, abundance, and value; the best means of preserving the more valuable kinds, and the methods to be employed in reclaiming those ranges which have been rendered of little or no value for grazing, through overstocking or other causes. In order to obtain a more definite idea as to what the present conditions and greatest needs are, and to gain all possible information that will aid us in determining the most practical methods of improving these conditions, by the introduction and cultivation of new grasses and forage plants or by the preservation and cultivation of native species, correspondence is hereby invited with all interested in the development and preservation of the stock-raising and dairying industries.

There are over 225 different grasses native to this region, and it would be difficult to give an adequate estimate of their immense value as a natural resource. Ever since the Northwest has been settled these grasses have been the chief source of food for the many thousands of horses, cattle, and sheep raised there, and many of them will undoubtedly prove more valuable under cultivation than they are in the native state.

Any assistance you may render in this undertaking, either by sending us the names and addresses of leading farmers, stock raisers, and dairymen of your region, or by furnishing information relative to the points above indicated, will be highly appreciated

Yours, truly, F. LAMSON-SCRIBNER,
Agrostologist.

Approved:
JAMES WILSON,
Secretary of Agriculture.

(1) What is the chief forage problem in your section—that is, do you need hay plants, soiling crops, drought-resistant crops, winter forage, or early spring or late autumn forage?

(2) How many head of cattle, horses, or sheep can be safely pastured to the square mile under existing conditions?

(3) Has the stock-carrying capacity of the ranges and pastures in your section been diminished through overstocking or other causes? If so, to what extent?

(4) What treatment do you recommend for restoring, renewing, and improving the ranges where they have been overstocked?

(5) What are the most highly valued native grasses and forage plants, and are there any tame grasses or forage plants which might be profitably introduced on the ranges to take the place of the valuable wild grasses of former years?

(6) What is the general character of the land in your locality, and what grasses flourish best on it?

Answers were received from about 600 persons, and the following may be taken as representative of the ideas expressed by the great majority of them.

From Governor Robert B. Smith, of Montana, the following answers were received:

(1) We need drought-resistant crops and winter forage.

(2) Fifty head of horses or cattle or 250 sheep.

(3) Where sheep range, destroyed at least one-half.

(4) If sheep were compelled to be kept in certain portions of the range and the remainder left free for cattle or horses, the range would be fully restored in three years. Sheep destroy the range; cattle and horses do not.

(5) Blue-joint and buffalo-grass are the best native grasses. Do not know of any tame grasses to take their places.

(6) Light gravelly land; soil not deep but rich, and with large per cent of alkali. Buffalo-grass and blue-joint flourish best.

From Hon. John C. Bell, M. C., of Colorado:

(1) In the Uncompahgre, Gunnison, and Grand valleys, the San Luis Valley, and the upper portion of the Arkansas Valley, our great field plant is alfalfa. The mountain sides, mesas, and foothills are covered with bunch grass which supplies all herds from about April 1 to December 1. If we could find some grass that would flourish in the low foothills without irrigation for winter feed it would be a great boon to all of Colorado. Our summer forage is ample and of the very best quality.

(2) The ranges vary so that no approximate estimate can be made. On some high mesas where the snow is deep in winter the grass is very abundant, but lower down it decreases. But these ranges are ample for all the stock that can be wintered in the valleys below.

(3) Not in the mountainous regions.

(4) Cattle and horses rarely impoverish a range, as they do not feed in close bunches, but sheep tramp out and practically destroy the grasses wherever they are kept. Horses and cattle will not remain or feed with them on the range.

(5) Bunch-grass and blue-stem in the mountain regions can not be surpassed unless some grass could be found that would stand the drought in the foothills.

(6) We have three varieties—adobe, black loam soil on the river bottoms, and the high "red oxide" mesa lands. Vegetables grow best on the black loam, wheat and oats on the adobe, fruit trees and alfalfa on the high mesa, though it is all better than the average lands of the country for any of the ordinary crops, and would probably produce most of the common grasses, though but little experiment has been made in this direction.

From Hon. Jos. M. Carey, Cheyenne, Wyo.:

(1) The introduction of a forage plant that will mature during our short seasons and will afford good grazing all the year, the seed of which would germinate and grow by simply being raked or "disked in" on the native sod. The native grasses are so valuable that it would be unwise to destroy them, but with nutritious grasses to supplement them the capacity of a given section for grazing purposes might be greatly increased.

(2) This depends upon circumstances. Some sections as they were left by nature would scarcely carry an animal; others, 30 to 40 head. Should say average 15 head for three hundred and sixty-five days.

(3) Yes; but as soon as cattle are removed the ranges again grow up to the native grasses. When I speak of cattle I mean neat cattle and horses. Where sheep graze for a number of years weeds take the place of native grasses.

(4) Rest.

(5) Bunch-grass, blue-stem, and buffalo-grass are the varieties best known to stockmen. I do not know of any.

(6) Sod free from brush of any kind. The native grasses referred to; with irrigation all of the small grains and forage plants that are common in this latitude produce well. Alfalfa does well everywhere in this State when irrigated, where the altitude is not over 5,000 feet. Three crops may be harvested; season's production, from 3 to 6 tons an acre.

A glance through this correspondence shows at once that not one but many problems relating to the forage supply demand attention. Localities having like soil and climatic conditions may still differ widely as to the most pressing needs. Thus, in one locality the greatest need may be early spring forage, in another it may be winter forage, and in still another it may be summer feed, while in many localities it is a question of a general shortage for the entire year.

The study of the forage question in the West and Northwest has not

been carried far enough to give us solutions to all the problems confronting the stockman, but it has been sufficient to reveal pretty clearly the causes that have led up to the present exhausted condition of the range. It shows that the past methods of handling the range have been shortsighted, and that while these practices are being in a measure corrected by the natural course of events, it is imperative that steps should be taken to restore and preserve the productiveness of the native meadow and pasture lands before the destruction has gone too far. The improvement in the native forage noticeable in some localities during the past one or two seasons is likely to be but temporary, as already stockmen in these localities are trying to increase their herds, and the lands will soon be overstocked again.

The investigation has also resulted in a large amount of valuable data regarding the native grasses and forage plants, the wealth of species found in the region, their value in the natural condition, and their possibilities under cultivation. There can scarcely be any doubt that some of these native forms will ultimately become as valuable for general cultivation as many of the so-called "tame" sorts.

GENERAL TOPOGRAPHICAL FEATURES OF THE REGION.

The topographical features of the three States comprising the greater part of the Eastern Rocky Mountain region are, in many respects, very similar. The continental divide, which traverses Montana about 100 miles east of the western boundary and nearly parallel with it, enters Wyoming a little to the southward of the northwestern corner of that State and continues its general trend to the southeast until it reaches central Colorado, where it turns rather abruptly to the southwest. Approximately five-sixths of Montana, three-fourths of Wyoming, and two-thirds of Colorado lie east of this divide. While in each State the greater part of the mountain area is found in the immediate vicinity of this divide, numerous outlying ranges occur which exert a great influence, not only upon the physical character of the country, but also upon the climatic conditions, particularly in the distribution of the moisture; as, for example, the Big and Little Belt Mountains, Snow Mountains, Bears Paw Mountains in Montana, Shoshone Mountains, Big Horn Mountains, Bear Lodge Mountains, and Laramie Mountains, in Wyoming, and the Sangre de Cristo and other ranges in Colorado.

In most cases the mountains along the main divide are rugged, with precipitous sides, more or less thickly covered with timber, which is chiefly evergreen, or coniferous. Sometimes the forest covering is so heavy that the growth of grasses is very limited, but usually there are numerous "parks" or "opens," in which flourish certain grasses and other forage plants. The slopes of the mountain ranges are cut up by numerous gulches and canyons, through which flow streams of water, fed largely by the melting snows on the mountain tops. The valleys of these streams widen out here and there into grass-covered areas of

various sizes, forming the "mountain meadows" for which this region is justly famous. The valleys of many of the larger mountain streams, uniting with those of their more important tributaries, often form areas of considerable extent, in which, because of the rich soil and abundant supply of moisture, luxuriant growths of native grasses are produced. These areas, variously called "basins," "parks," etc., protected as they are by mountains on all sides and provided with an abundance of excellent forage and pure water, are magnificent natural pastures, whose only drawback is that often the altitude is so high and the snowfall is so great that they can be used for only a limited portion of the year. (See fig. 2.) Excellent examples of these areas are Spanish Creek basin, in southern Montana; Centennial Valley, at the head of the Little Laramie River, in Wyoming, and the numerous "parks" of Colorado.

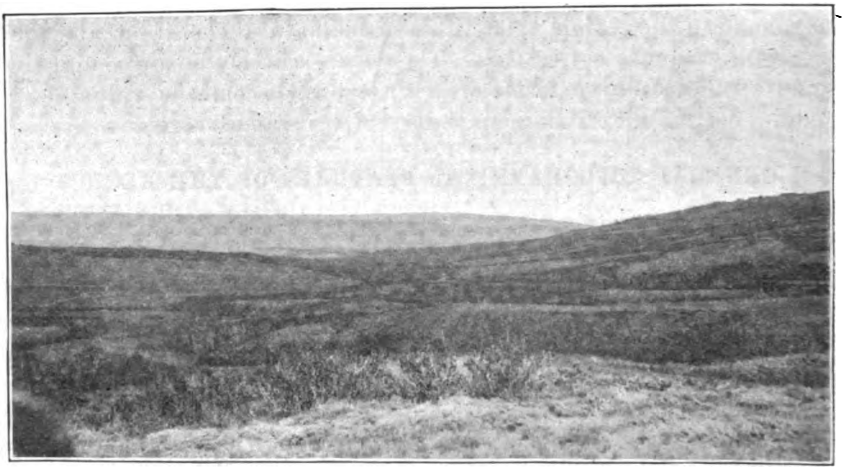

FIG. 2.—The ideal summer range. (From photograph by Prof. A. Nelson.)

In some of the outlying ranges the mountains are less rugged, the slopes are often but sparsely or not at all wooded, and hence offer proportionately larger forage producing areas. For example, the Big Horn and Bear Lodge ranges, in Wyoming, contain large areas of grass lands, the former expanding toward the south into a broad, irregular plateau, a very considerable portion of which is covered with a fine sod of native grasses. In many portions of this region the mountains are fringed with an irregular series of foothills, which pass sometimes abruptly, sometimes gradually, into table-lands or mesas, and these in turn are followed by broad valleys and open prairies or plains proper. The frequent arrangement of the land along streams into terraces or successive "benches" is of considerable importance from an agricultural point of view, since very often the table-lands differ considerably from the valleys below as to the supply of moisture and the earliness and length of the growing season. This is well illustrated by the Gallatin Valley about Bozeman, Mont., where the season is much

earlier on the table-lands. Often it is a difficult matter to get water for irrigation upon these benches, and farmers must depend upon the snow and rain for the supply of moisture for their crops. Along some of the streams, as in the case of the Big Horn River in Wyoming, there are no benches or terraces, the valley being limited by high, abrupt bluffs leading to the uplands which rise gradually to the foothills and mountains.

Extending to the eastward from the principal ranges of the Continental Divide are the vast stretches of level plain, rolling prairie, and rough, eroded bad lands, constituting the great range region east of the Rocky Mountains. Over a considerable portion of this region rugged buttes are scattered here and there in addition to the previously mentioned outlying mountains, relieving the monotony of prairie and plain and affording welcome landmarks for the cowboy and traveler. Occasionally considerable portions of the plains area are cut off from the remainder by natural barriers of hills and mountain ranges, forming drainage basins of considerable extent, as in the case of the Judith basin, in Montana, and the Big Horn basin and the Laramie plains, in Wyoming.

THE SOIL.

The character of the soil in the eastern Rocky Mountain region is exceedingly varied. According to Prof. W. C. Knight, "the various geological formations which have entered into the soils of Wyoming range from Archæan to the Pliocene Tertiary," and the great variability in the composition of the different soils is readily explained from the fact that "some of them have been derived from the entire series of rocks ranging from the Archæan to the close of the Tertiary, while others are the result of the decaying of a single geological horizon." These statements are essentially true of Montana and Colorado. The soil in the valleys varies from light sandy loam to a heavy black loam or a stiff clay. Sometimes a great deal of gravel is present, and often, particularly in the higher valleys, the surface is strewn with bowlders of various sizes brought down by glaciers or mountain torrents. These bowlders are particularly abundant in the valleys of some of the streams rising in the Big Horn, Shoshone, and Medicine Bow mountains, often rendering it practically impossible to drive through with a wagon. The ranchers assert that when the land is brought under irrigation these bowlders gradually work into the soil and in a few years all the smaller ones disappear beneath the surface, making it possible to use the land for hay meadows. The soil is usually fertile and gives excellent yields of grass. In many places the clay contains quantities of "alkali" and constitutes the so-called "gumbo" and "adobe" soils. The soil of the foothills and mesas is usually quite sandy or gravelly, and is warmer, and hence earlier, than the heavier soil of the valleys. On the prairies and plains the soil varies from a sandy to a clay loam, in some places thick and well sup-

plied with humus, in others thin and poor. Throughout the greater part of this region the subsoil is clayey, but in some localities, particularly near the mountains, where the drift and wash is great, it may be quite gravelly in nature. Over the entire region, outside of the mountains and higher foothills, the soil is characterized by the presence of a greater or less amount of alkali. In the well-drained soils of the foothills, mesas, and rolling prairies the amount of alkali present is usually small, but in the broad, flat valleys and level plains it is often large—sometimes so great as to completely change the character of the vegetation. (See fig. 3.) The water from rains and melting snows passes over and through the surface soil and leaches out the alkali, which is carried to the streams, lakes, and ponds. Naturally, much of this water is gathered into low places in the plains and valleys, where it is evaporated rapidly, leaving the alkali in the surrounding soil. In many places the alkali has been brought to the surface in considerable quantities as a result of improper irrigation. This is especially likely to occur if water is used in large quantities and then allowed to evaporate from the surface. This may be avoided in a large degree by frequent and shallow cultivation after each application of water. Often the water used in irrigating is heavily charged with alkali, which, added to that already present in the soil, ultimately renders the latter unfit for the successful growing of the ordinary farm crops. In popular parlance there are two kinds of "alkali" lands—"black alkali" and "white alkali." The former owes its peculiarities to the presence of salsoda (sodium carbonate) and the latter to the presence of Glauber salt (sodium sulphate) and Epsom salt (magnesium sulphate). The "black alkali" is much more injurious to vegetation than the "white alkali," and fortunately is much less common in this region.

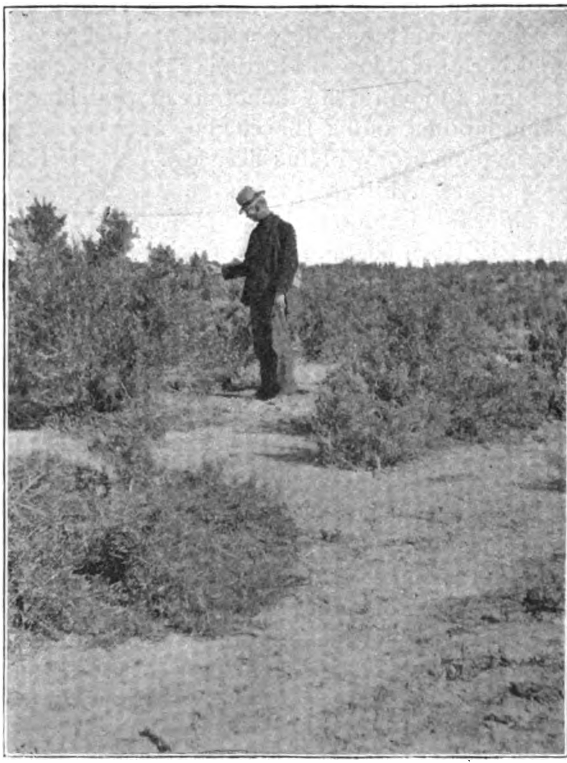

FIG. 3.—An "Alkali spot," showing characteristic greasewood vegetation.

THE WATER SUPPLY.

Over a considerable portion of the region under consideration the annual precipitation, or rainfall, is quite limited. In the great-plains area it is not probable that the average would be over 10 or 12 inches per annum—more in the favored localities and less elsewhere. On the mountains and in their immediate vicinity water is usually abundant, and were it not for the many lofty peaks, whose perennial snows supply the streams originating in them, the country would be a desert indeed, and agriculture impossible. As it is, the farmer or stockman is filled with joy when he sees the mountain tops becoming whitened with heavy snows; for they promise him a plentiful supply of water for his crops and his stock during the summer months. Countless streams fed by these snows find their way down to the plain, where they unite to form the larger water-courses—the Missouri, Yellowstone, Platte, and Arkansas rivers. Were it possible to properly husband the water flowing in these streams so that it could be distributed over the land when it is most needed, the forage problem would be a simple one and easily settled in a very large portion of this region for a long time to come.

Under the present condition much of the water runs off during the spring freshets and is lost, while crops and stock often suffer severely for water later in the season. This trouble is sometimes aggravated by the removal of the forest cover in the mountains by fires or by the wholesale cutting of timber. The proper maintenance of this forest cover about the source of the streams furnishing water for irrigation is a matter of vital importance to this whole region, and every possible effort should be put forth to secure it from destruction. A correspondent from Routt County, Colo., writes, "The greatest evil to the range is the destruction of the timber and underbrush at the head of the streams through fires," and many other correspondents have expressed similar views. A good illustration of the injurious effect of the destruction of the forest cover was observed the past season in the Big Horn Mountains, where thousands of acres of spruce and pine timber have been killed by fire, allowing the early and rapid running off of water from the melting snows, and a consequent shortage later in the season in the streams depending upon them for their supply.

Out on the plains, away from the mountains, not only is the precipitation less, but the streams are farther apart, and many of them, because of the excessive evaporation or porous character of the bed, become dry during the summer and autumn months, so that the water supply is insufficient for irrigation, and often it is difficult and sometimes even impossible for the rancher to obtain enough to water his stock. Animals wandering back and forth in search of water trample out and destroy many of the valuable grasses which would otherwise be able to survive the drought. During freshets resulting from melting of the snows in the spring on such a wide expanse of territory, with little if

anything to retard the rush of the water into the streams and low places, immense quantities of water are entirely lost. Again, the rain often comes in such sudden and violent storms that but a small proportion of it has time to soak into the soil, the rest rushes into the watercourses, and is speedily carried away. Thus many localities suffer from lack of water, although the annual precipitation, could it be preserved, would, perhaps, be amply sufficient for present needs.

The Belle Fourche River drains a considerable territory in northeastern Wyoming, and during the spring it becomes a raging torrent, carrying off immense quantities of water, while it is often so low during the dry season that no water runs through it in the upper part of its course. The construction of reservoirs to catch and retain the water from the rains and melting snow would undoubtedly go a long way toward the solution of the forage question in many localities on the open ranges. In many places there are natural basins which could be made into reservoirs at a very small expense compared with the great good to the farmers and stockmen which this conservation of water would accomplish.

The excessive trampling of the stock and consequent packing of the soil and the destruction of vegetation in the immediate vicinity of the springs and small streams are no doubt largely responsible for the fact that many of them are now dry for some time during the summer and autumn, though in former years they furnished water throughout the season. Very naturally the stock eats the forage nearest to the watering places first. Soon the vegetation becomes closely cropped, and as the animals visit the watering places daily, the plants are allowed no opportunity to recuperate, and as a result the ground is soon almost or quite destitute of vegetation.

PRESENT ASPECT OF THE FORAGE PROBLEM.

The aspect of the forage question has changed very materially throughout the eastern Rocky Mountain region in the past ten or fifteen years. Formerly comparatively little general agriculture was practiced, except in a few localities near the larger cities and towns. Lack of moisture or of facilities for irrigation made it difficult to secure good crops. Many of the early settlers were engaged in mining, and in the eager search for gold and silver found little time or inclination to engage in agricultural pursuits unless forced to do so by the failure of their mining ventures; others, noticing the great abundance of nutritious forage, bent their energies toward getting together as much stock as possible in order that they might take full advantage of this great natural resource. This course soon resulted in the establishment of numerous large ranches, each controlling a wide stretch of territory, and naturally discouraged the taking up of tillable lands for general agricultural purposes. Hence, farming was largely confined to small inclosed areas on the ranches and to the more protected localities

near the larger settlements. Owing to the light rainfall during the summer and autumn the native grasses cured on the ground in such excellent condition that little if any hay or grain was necessary to carry the stock through the winter, and the rancher preferred to buy imported flour and canned fruits and vegetables than to bother about farming.

Upon the advent of the recent series of dry seasons it soon became evident that the ranges were too heavily stocked. Ranchmen were forced to provide forage for their stock in order to carry it through the winter. This has led to the fencing of hay meadows and the cultivation of alfalfa, timothy, and other hay and forage crops. But this made stock raising more expensive and forced many of the large concerns to go out of business. Then, too, as irrigation began to be practiced it soon became evident that many portions of the region were adapted to general farming, and settlers began to take up the land along the streams and to plant it to crops of various kinds. This interfered with the methods of ranging stock practiced on the large ranches, and the stockmen were forced to reduce their herds or seek new ranges. Very often it was found to be more profitable to divide the big ranch into small holdings and sell or rent to farmers and small ranchmen than to continue in the stock business.

In many instances the stockmen owned but little, or none, of the land over which their stock grazed, and their improvements were of little value. In other cases large tracts of land had been purchased or leased and considerable sums of money expended in building fences and making other improvements. As the country has become more and more settled, the former class has largely disappeared. The ranches of the latter class have either accommodated themselves to the changed conditions and developed into the large successfully conducted stock-growing establishments of to-day or have given way entirely to the smaller ranch and farm, where a combination of stock raising and crop growing is practiced.

This changed condition of things is very apparent in northern Wyoming, where in many places the land of the valleys has recently been brought under irrigation and affords fine crops of wheat, oats, rye, barley, early corn, timothy, clover, redtop, and alfalfa. On the Gray Bull River and elsewhere in the Big Horn Basin the change has been brought about largely within the past five or ten years. Instead of the large herds, controlled by a comparatively few wealthy men or by stock companies, the tendency is toward the smaller herds of the individual rancher. Instead of depending so largely upon the Southwest for young cattle the ranchmen are beginning to raise more young stock themselves, and they are beginning to handle better-bred animals and to bring them to a marketable condition at an earlier age.

One of the most pressing needs of this region is a hay plant that will endure the dry weather and afford profitable yields. In localities where

water can be had for irrigation there is usually little difficulty in raising plenty of alfalfa, and then the need is for a supplementary hay or forage of some sort in order that the alfalfa may be fed to the best advantage. For much the greater portion of the region, however, irrigation is either impossible or impracticable, and here a drought-resistant grass or forage crop is very much needed. Nearly six hundred farmers and stockmen, representing nearly every county in the States of Colorado, Wyoming, and Montana, and many from adjoining States, in answer to the question, what is your present greatest need in the way of forage, place hay and winter forage first, almost without exception. In some localities winter pasturage is deemed more necessary than hay or coarse forage, but with the changes in the methods of handling cattle and the growing tendency toward winter feeding the use of various kinds of hay and fodder crops is yearly becoming more general. This, together with the fact that in many localities the range has been so reduced by drought and overstocking that it is hardly sufficient for summer paturage alone, making winter feeding absolutely necessary, renders the demand for hay and fodder crops imperative. Then again, the heavy losses of stock during some of the severe storms of recent years have taught the ranchmen the necessity of providing winter feed as a precautionary measure, if for no other reason.

Of scarcely less importance than winter feed, and by some ranchmen regarded of even more importance, is the need of early pasturage. There is a period of a month or more, after the breaking up of winter and before the native grasses get started, which is one of the most critical for the ranchmen of this region. Stock is more or less weakened as a result of the winter season, and palatable food is usually exceedingly scarce. The stockmen say that if some grass could be introduced that would provide pasturage earlier than the native grasses do, it would be worth many thousands of dollars to them annually.

Another matter of great importance to the ranchmen of the Northwest is the question of autumn forage. The native grasses on the open ranges dry up in the latter part of the summer. Formerly the growth was sufficiently abundant to provide plenty of well cured nutritious forage, but now the ranges are so bare in many localities at the end of the summer that stock can get practically no autumn grazing outside of the fenced areas. Near the mountains the custom is to range the stock in the higher foothills and mountain valleys during the summer, and upon the appearance of the early snows to take it down into the lower foothills, where it is kept during the autumn, or often the entire winter; but in many places drought and overstocking have so depleted these fall and winter grazing lands that they now afford comparatively little forage and are becoming covered with worthless weeds. In such localities it is necessary to begin feeding the stock long before winter begins in order to keep it in good condition. The rancher regards as his most favorable season one in which there is a heavy

rainfall during the spring and early summer months, a dry autumn and an open winter, with little snowfall or with high winds to blow the snow into the ravines and gullies. This gives a heavy growth of grass, which cures on the ground, where it can be grazed by the stock during the late fall and winter.

A considerable portion of this region has an altitude too great for the successful growing of alfalfa and other commonly cultivated forage crops, although it includes a great deal of rich land well supplied with natural moisture or capable of being irrigated readily. Thus in Montana the altitudinal limit for the successful growing of alfalfa ranges from about 4,500 to 5,000 feet, and more than one-half of the total area of the State is above this limit; in Wyoming its altitudinal limit seems to be not far from 5,000 feet, and over three fourths of the State is above this altitude; in Colorado it can be successfully grown up to about 6,500 feet in the northern and 7,500 feet in the southern part of the State, and nearly one-half of the State is above this limit. Timothy can usually be successfully grown at an altitude of from 500 to 1,000 feet above that of the limit for alfalfa, and hence replaces it to a greater or less extent, but there is a very decided demand by the farmers and stockmen for a forage crop adapted to these higher altitudes. Mr. T. P. McDonald, of Carbon County, Mont., expresses the sentiment of many when he writes, "We need a good forage plant that will grow and mature above the 5,000-foot level."

In addition to the above-mentioned needs, all of which are of quite general importance, there are many of more or less local significance demanding the attention of the investigator and the farmer. Although alfalfa and other coarse crops can be raised successfully in most localities and are good for hay, they are not satisfactory for general pasturage, and there is a demand for a good pasture grass to be grown under irrigation. In other localities the land is too strongly impregnated with alkali, either from natural causes or through injudicious irrigation, for the successful cultivation of the ordinary forage crops, and plants are desired that will flourish on such soil. In still other localities, particularly near the larger cities and towns, crops suitable for soiling are needed.

In some instances the present lack of forage is due quite as much to the slowness of the farmers and stockmen to adapt themselves to the existing conditions as it is to the want of suitable crops for cultivation. It is hard to get out of the old slip-shod ways, even though it is known that a little well-directed effort will make a given amount of land yield several times as much forage as it did formerly. Careful attention to the development of native meadows and pastures and a more general cultivation of miscellaneous forage crops that can be grown with at least a fair degree of success in nearly all localities will do much toward solving the forage problem.

The effect of such effort is well illustrated by the excellent native

meadows that have been produced by intelligent irrigation, examples of which may be seen along the valleys of the Platte, Bear, Gallatin, and Belle Fourche rivers, in the Big Horn Basin, as well as along many other streams of the region. On the other hand, the injurious effect of careless treatment is very apparent on many ranches where, because there is a great abundance of water, the meadows are kept so wet that the better grasses are driven out and their places taken by sedges and rushes, producing an inferior quality of hay.

The following description of the conditions prevailing on the range between the Missouri River, in South Dakota, and the Upper Belle Fourche River, in Wyoming, may be taken as typical of those obtaining over the Northwest generally and illustrative of the marked effect that an isolated mountainous region like the Black Hills may have upon forage production and agriculture in general. The notes were taken during a wagon trip from the Cheyenne Indian Agency, on the Missouri River, up the Moreau River and across to the Belle Fourche River, in northeastern Wyoming, and back through the southern Black Hills to Pierre, S. Dak.

FORAGE CONDITIONS ON THE RANGE OF WESTERN SOUTH DAKOTA AND NORTHEASTERN WYOMING.*

CHEYENNE AGENCY TO BELLE FOURCHE RIVER.

This region varies greatly in the character of its surface. The land near the streams, especially the Moreau and the Missouri rivers, is exceptionally rough. There are no great elevations or depressions, but the smaller ones are a host. Back 3 or 4 miles from the river there are table lands of considerable extent which are comparatively level, even in the lower course. Farther west the country is not so rough, the region from the mouth of Thunder Creek to the Belle Fourche being an undulating prairie.

The soil over a large part of the eastern portion of the region resembles that east of the Missouri River very much. The humus decreases gradually to the westward and one encounters more gumbo. The whole region is covered with grass except occasional small spots of gumbo and the steeper bluffs along the Moreau and Missouri rivers. The eastern portion of the region differs from the western also in having fewer sandy knolls.

All the streams tributary to the Moreau and Cheyenne are wooded to some extent. There are two or three conditions which are suggestive in regard to the growth of timber. The soil is heavy and does not allow the water to percolate through it very easily, but when once started washes badly. This leads to washouts and holes in the stream

*Abstract from the report of Mr. David Griffiths, who served as field agent for the division in South Dakota and Wyoming under a commission extending from the middle of July to the middle of September, 1897.

beds which hold water until late in the summer. The trees getting started around these water-holes are supplied with sufficient moisture during the growing season. The stockmen and Indians have exercised much vigilance of late in keeping out fires. Near Bixby it was stated that it has been ten years since fire has passed over that region. When fire does get started, it is not so destructive to trees and shrubbery as it would be if there was more grass on the ground. Almost invariably we found the feed very short near the water-holes. During the summer the range cattle feed near the water, working back on to the open range as feed conditions demand. Consequently, by the time vegetation is dry enough to burn, the grass in the vicinity of the water-holes is very short and fire does not do so much damage.

FIG. 4.—Fresh-water cord-grass (*Spartina cynosuroides*): *a*, spikelet, showing three stamens; *b*, spikelet, showing the projecting stigmas of the pistil; *c*, the same, with the outer glumes removed.

The timber along the Moreau is made up of cottonwood, willows, buffalo berry, box elder, green ash, white elm, plums, and cherries, with buck-bush, poison oak, and various species of rose as undershrubs. On the bluffs on either side are found *Rhus trilobata* and an occasional red cedar. Sage-brush (*Artemisia longifolia*) is common over limited areas in the western portion of the region, while species of cactus are common everywhere.

The feed on the Indian reservation is much superior to that farther west, the main reason for this being that it is not pastured so closely. The Indians have only a few cattle, and it appeared that they were taking considerable pains to keep the feed along the Moreau River for winter use. However this may be, we saw but few cattle on the river bottom while on the reservation. Neither were any Indians seen excepting at three points on the river. Their log houses and stables were in evidence all along, but no Indians or cattle to speak of. They were

congregated at White Horse camp and the agency. Near each one of these houses was a small piece of ground, from 2 to 3 acres, fenced and under cultivation. Their crops consist of corn, potatoes, pumpkins, and melons. These were usually well tended and a good crop. There were a few pieces of wheat which were an average crop. The Indians evidently do not cultivate the same piece of ground for many years in succession. It was not an uncommon thing to find patches of ground, which had once been under cultivation, all grown up to weeds, and the fence removed from it, possibly to get fresh soil, but probably more often to get rid of the weeds. It was learned that the Indians make almost no preparation for winter feeding, except to save, as much as possible, the feed around their winter quarters. As they have but a small bunch of cattle, they are able to keep close watch of them. Quite a number of cattle were seen which were being driven down to the agency to be sold for beef. They were invariably in good condition.

After leaving the Missouri bottoms no big sand-grass (*Calamovilfa longifolia*) was noticed until the party arrived at the Moreau near White Horse camp. Big cord-grass (*Spartina cynosuroides*) (fig. 4) is the principal grass along the ravines and gullies, and big sand-grass is very common on the knolls farther west. The distribution of big sand-grass, of course, throws much light on the character of the soil. Both of these grasses were pastured closely in the western portion of the region where the feed was short. Usually these grasses are not cut for hay, but this season it is said that they will form the bulk of it, owing to the scarcity of wheat-grass.

Prairie June-grass (*Koeleria cristata*) is a much more important grass on the high prairie in the eastern portion of this region than anywhere else we visited. The small table lands back 3 or 4 miles from the river invariably contain fine growths of this grass, at times almost to the exclusion of the other grasses. There was a large area near Virgin Buttes that stood 10 inches high and so thick that the heads which were then ripe gave a brown appearance to the whole area. It is very common on all the high ground.

Porcupine-grass (*Stipa spartea*) and needle-grass (*Stipa comata*) are found to some extent all along the Moreau bottoms, the latter becoming a very important pasture grass to the westward. Feather bunch-grass (*S. viridula*) is more important on the highland regions eastward. Here it is a very valuable pasture grass and is often found with western wheat-grass (*Agropyron spicatum*) and blue grama (*Bouteloua oligostachya*) in sufficient quantity to make considerable hay.

The more important grasses and forage plants of the region are as follows: Blue grama (*Bouteloua oligostachya*), western wheat-grass (*Agropyron spicatum*), big blue-stem (*Andropogon provincialis*), prairie June-grass (*Koeleria cristata*), big cord-grass (*Spartina cynosuroides*), needle-grass (*Stipa comata*), feather bunch-grass (*S. viridula*), big sand-grass (*Calamovilfa longifolia*), buffalo-grass (*Bulbilis dactyloides*),

Dakota vetch (*Lotus americanus*), wild rye (*Elymus canadensis*), and *Carex filifolia*. The last is of special value early in the season.

Dakota vetch (*Lotus americanus*) is very abundant along the river bottoms. There are often large patches of it which are almost pure. If this proves valuable under cultivation it will be easily propagated, for it produces an abundance of seed. It has, however, the disadvantage of ripening its seed unevenly. Usually the older pods have burst open before the later ones have ripened.

BUTTE POST-OFFICE TO DEVILS TOWER.

The change that takes place as one proceeds along the Owl Butte road from Dead Horse Creek toward the foothills of the Black Hills is something wonderful. One passes from a region where the ranches are 5 to 40 miles apart, where there is practically no cultivation, and where there is nothing to break the monotony of the scene but bunches of cattle feeding in the "draws" and an occasional patch of scrubby box elder and ash on the creek bottoms, to a thickly settled region, where there are good buildings, excellent crops of grain and hay, and where everything in the shape of vegetation makes a thrifty growth. The greater part of the land along the Belle Fourche from Butte to the Tower is fenced, either for growing cultivated crops or for winter feed. For about half the distance from Butte to Belle Fourche the route was through a narrow lane left for a road and in which there was no feed whatever—everything being pastured closely. The farmers fence their crops, pastures, and hay land, and turn their cattle out into the roads which lead into the Black Hills on one side and into the open range on the other. The party, at times, experienced some trouble in finding feed for their horses.

Nearly everything depends on irrigation here, the water being carried from tributaries of the Belle Fourche by a system of ditches and sluices onto the land. Nowhere is water taken from the Belle Fourche itself, the reason being that the river has not sufficient fall to enable farmers to get the water onto the land without too great an expense. It was learned also that the volume of water in the river fluctuates greatly, a rise of many feet occurring in a few hours at times when heavy rains fall in portions of its drainage basin. Damming has been tried in several localities without success. As the tributaries from the hills are quite numerous, the farmers are usually able, by judicious management, to get a sufficient volume of water for their crops from them. Usually the water is exhausted before the middle of July, but by an intelligent use of their supply during May and June they are able to raise fine crops. In many instances the farmers get along by building a dam across a gully and holding the water derived from melting snows and spring rains until it is needed later in the season. In the immediate vicinity of Belle Fourche opportunity was afforded to study the effect of an abundant supply of water the entire season. It is here obtained from one of the tributaries of the Red Water.

Here was found a most luxuriant growth of both native and cultivated vegetation. As fine fields of wheat were found here as in the great small-grain belt in the eastern part of the State, while the hay crop was something wonderful. The unirrigated lands, however, presented an appearance not unlike the drier portions of the open range farther east.

The principal hay crop is alfalfa, of which, they obtain about 4 tons per acre from three cuttings, which is the usual method of handling. The farmers were experimenting with a fourth cutting this year, and were considerably encouraged over the prospect at the time the region was visited. This crop is prized very highly because of the fact that they are able to get such a yield per acre. Many other hay crops are grown very successfully, but none yields such a quantity of feed as this one.

Redtop makes the finest growth here of any place visited on the trip. On the Seth Bullock ranch there is a large meadow which was sown to redtop and timothy eight or ten years ago. The timothy is now nearly all run out, while the redtop this year is a fine stand about two feet high.

Besides the above may be mentioned timothy, white sweet clover (*Melilotus alba*), millet, and June clover, all of which make good growths. White sweet clover (*Melilotus alba*) is so persistent in its habits that it assumes much of the characteristics of a weed along the ditches and among other perennial forage crops. It makes an immense growth wherever it gets started on irrigated land. At Belle Fourche was seen near a spring about an acre that stood about 9 feet high.

Native grasses are also irrigated with good success. When, however, a piece of ground is irrigated year after year, that invaluable species, *Agropyron spicatum*, runs the other grasses out. Several instances of this were seen and attention was called to it, not only in the vicinity of Belle Fourche, but farther west, in Wyoming, as well. The most striking example was near Snoma, S. Dak., where there was a meadow of 30 or 40 acres of this grass, with a crop of about 2 tons to the acre. About one-fourth of it was headed out. It was raining at the time of the visit and the grass, therefore, looked fresh and thrifty. Such a large field of this glaucous-leafed grass made a very pretty sight. It was ascertained that this meadow had been irrigated and cut for five consecutive years with a good crop of hay upon it each year. Such a condition is really extraordinary, for ranchmen on the range and even the farmers in the eastern part of the State are seldom able to cut crops of this on the same ground for more than two years in succession. Even when pastured closely year after year the quantity of feed becomes very small. But this is simply one more evidence of what a proper amount of water will accomplish when applied to this soil.

Barnyard-grass (*Panicum crus-galli*) makes a fine growth along the ditches and roadsides where the sod has been partially subdued. It

has two distinct forms of growth. Along the ditches and among other grasses it assumes an upright form, while along roads and in barnyards, where the ground is packed down to some extent, it is almost prostrate and often strikes root at the joints. It appears to thrive as well under this form of irrigation as it does under artesian irrigation in the eastern part of the State.

Squirrel-tail grass (*Hordeum jubatum*) is a bad weed wherever the perennial grasses are irrigated on low, alkaline ground.

Besides the usual forage crops there is a great deal of rye, wheat, and oats cut for hay. Winter rye is usually sown. These crops are resorted to only in the drier portions of the region or where no water is available for irrigating purposes. Although small grain is raised here successfully with irrigation, the main crop is hay. There is considerable feeding done during the winter. The big cattle companies make provision with the settlers here, and also with the ranchmen farther out on the range, for the wintering of calves and weak cows which are picked up during the last beef "round-up" in the fall.

The distribution of precipitation is very peculiar. The rainfall is much more abundant in the vicinity of the Black Hills than on the open range on either side. While irrigation is resorted to with profit wherever practicable, the region is not dependent on it entirely. Occasionally good crops of grain are raised without irrigation, but it is rather uncertain. When wheat and oats are sown for the grain and the crop proves to be a failure, it can usually be told in time so that it can be cut early enough to make good hay, which is always in demand. In the vicinity of Sundance, Wyo., and elsewhere along the base of the Bear Lodge Mountains, very fair crops are usually raised with no artificial watering. This year the prospects near Sundance were very good, but they had the misfortune of being "hailed" out.

The Bear Lodge Mountains are in general covered with pine (*Pinus scopulorum*), with an occasional grove of oak, poplar, and birch. The pine is especially heavy on the outer slopes of the mountains and in the "draws" and gulches farther up. Along the divides and edges of "draws" there is very fine pasturage. The range cattle do not get in here to any extent, partly from choice but principally on account of the fact that ranchers have fenced most of the land along the base of the mountains separating the open range from the mountain pasture lands. Common along the Bear Lodge Mountains is King's fescue (*Festuca kingii*), which makes a fine growth below the lower timber line and is very common at higher elevations. It is highly prized by the ranchmen along the base of the mountains on account of its early spring growth. It furnishes pasturage at a much earlier date than any other native grass. Occasionally it makes some hay, but it is looked upon as a pasture rather than a hay grass.

DEVILS TOWER TO NEW CASTLE.

As one proceeds up the Belle Fourche from the Tower he can not help but notice the gradual decrease of the pine timber. It becomes more and more scrubby until it practically disappears at the mouth of Wind Creek. On the bluffs on either side of the stream is a growth of pine, with some oak, and on the bottoms there is a good growth of cottonwood, with more or less of the buffalo berry, green ash, box elder, and an occasional plum and cherry thicket. There is always a very vigorous growth of roses, buck-bush, and sage-brush. There are large areas on the bottoms covered with long-leafed sage (*Artemisia longifolia*), almost to the exclusion of other vegetation.

Some difficulty was experienced in finding feed for the horses in the upper Belle Fourche region, not that the country is not productive, but there are too many cattle. It would be difficult to tell what grasses grow on the river bottom were it not for the winter pastures which are fenced in. During the two nights spent here the party managed to camp in these winter pastures where there were good growths of blue grama (*Bouteloua oligostachya*), needle-grass (*Stipa comata*), feather bunch-grass (*S. viridula*), western wheat-grass (*Agropyron spicatum*), prairie June-grass (*Koeleria cristata*), big sand-grass (*Calamovilfa longifolia*), big cord-grass (*Spartina cynosuroides*), slender cord-grass (*S. gracilis*), wild rye (*Elymus canadensis*), sand rush-grass (*Sporobolus cryptandrus*), and Montana sand grass (*Calamagrostis montanensis*). The main hay grass is western wheat-grass, which is cut in fenced areas along the river bottoms and farther back on the range, along creek bottoms. Water for irrigating purposes is rather scarce, but wherever found and used good crops of alfalfa are raised. The rainfall is much less than it is in the vicinity of the Bear Lodge Mountains. As near as we were able to learn the rainfall is seldom sufficient to mature a crop of small grain after one gets 10 miles west of the Bear Lodge Mountains.

It appears to be the common experience that native sod when irrigated grows up almost exclusively to *Agropyron spicatum*, which is known by the name of wheat-grass. Several instances of this were seen—one at Mr. Baugh's, another at Mr. McKean's, farther up the river.

A great deal of the country about Moorcroft is covered with species of sage-brush, salt-sage, greasewood, and cactus. This is in the edge of the sage-brush plains of Wyoming. To the east are the hills, covered with a good growth of pine. This condition continues nearly to Merino, where the railroad works back toward the western timber line of the foothills. The soil is largely of a clayey nature, much of it of the sort popularly called "gumbo," and washes very badly. The rain does not soak into the ground much, but runs off into the streams, often swelling them to enormous extent. Among the sage-brush and cacti are good growths of grasses, generally those which do not form a sod under ordinary conditions. Among the most important may be mentioned

needle-grass (*Stipa comata*) and western wheat-grass (*Agropyron spicatum*). On the divides are found big sand-grass (*Calamovilfa longifolia*) and blue grama (*Bouteloua oligostachya*), while big cord grass (*Spartina cynosuroides*) and salt-grass (*Distichlis spicata*) are the most common on the low ground. Needle-grass (*Stipa comata*) is a very important grass in this region. Northwest of New Castle, near the junction of the Burlington and Missouri River Railroad and Skull Creek, it is especially common. In this vicinity and extending southward into the oil regions are large areas among the sage-brush where no other grasses grow.

As one approaches Inyan Kara Mountain the country assumes much the appearance of that around Sundance, as would be expected. There are more streams, and consequently more water available for irrigation. The rainfall is also more abundant, and the soil has more sand and humus in its make-up. The mountain and all the elevations in the neighborhood are covered with pine, while groves of poplar, birch, and oak are common. The creeks have a growth of cottonwood, box elder, and green ash. Springs of pure soft water are common near the base of the mountain.

Near Inyan Kara we found a ranchman drilling with the expectation of getting a flow of water. He started in last year, when he struck a stratum from which water raised within a few feet of the surface. He renewed his efforts this year, hoping to get a sufficient flow to irrigate from. The open range is closely pastured here also. Here again it was learned that until about four years ago hay could be cut anywhere on the upland, but for the past few years the cattle have become so numerous that they keep the grass eaten off so closely that the effect is much the same as successive cutting year after year. Occasionally a ranchman attributes the short crop of the past few years to drought, but the majority of them agree that it is due to overstocking.

We found more and better farming along Skull Creek than along the Upper Belle Fourche. This is probably due largely to the better facilities for irrigation. There are ranches at short distances along the creek, and considerable hay was being put up. Alfalfa is their main crop whenever they can get water onto the land. Timothy is raised to some extent, and rye and oats are common hay crops. No running water was found until the party got down near the Burlington and Missouri River Railroad. There is as good an illustration of the effect of water on the growth of vegetation here as one could wish to see. On the one hand there is a perfect wilderness of sage-brush (*Artemisia longifolia* and *A. tridentata*) as far as the eye can reach, with the usual light growth of grass, forming no sod to speak of; on the other, native grasses, alfalfa, oats, and garden truck make a fine growth with artificial watering.

The arable land in the region between New Castle, Wyo., and Rapid City, S. Dak., is confined to the valleys and creek bottoms which lie between the different ridges in the Black Hills upheaval. The crops raised are about the same as at Belle Fourche and along the eastern foothills. It appears to be the practice in localities here as at Belle Fourche to seed for a crop of grain, and if the yield does not promise well it is cut for hay before it becomes thoroughly ripened. Some very fine crops of alfalfa, wheat, and oats were seen in Spring Creek Valley. Redtop and timothy are common on the larger areas of low ground. Redtop is especially abundant, and there was a fine crop of hay in Rapid Creek Valley to the southwest of Rapid City.

FIG. 5.—Buffalo-grass (*Bulbilis dactyloides*): *a*, female plant; *b*, male plant; *a'*, two clusters of female spikelets; *b'*, a branch of several staminate spikelets; *c*, a male or staminate spikelet of two flowers.

The climatic conditions are in marked contrast with those at a lower elevation. Harvesting was in progress in the vicinity of Belle Fourche the 1st of August, but 20 or 25 days later, when the party crossed the Black Hills on their return trip, a great deal of wheat and oats were still green. Only about one-half of the crop through the hills had been cut at this late date.

A beautiful arrangement of native grasses is found along the foothills near Rapid City. There are a great many cattle pastured here, and the grasses are consequently kept eaten down quite closely. There are three species, which form a perfect sod in places. The country is rolling—sometimes hilly. In the depressions are patches of ground several acres in extent which are as smooth as though they had been laid out by artificial means. On these areas are full sods of blue grama (*Bouteloua oligostachya*), black grama (*B. hirsuta*), and buffalo-grass (*Bulbilis dactyloides*) (see fig. 5), arranged in natural lawns, as it were, according to nature's own fantastic designs. It made a very pretty sight. No artificial lawn could be more desirable. The color of the grasses, so similar and yet so delicately different that each species growing in separate patches could be recognized at a considerable dis-

tance, the splendid sod, and the pleasing general effect suggested the possible use that might be made of these grasses for lawns, borders, and designs about dwellings, public buildings, and cemeteries.

RAPID CITY TO PIERRE.

Nowhere on the trip was better feed found than along the trail from Rapid City to Pierre. No pasturing had been done here except at certain points, as Pœno Hills and Grindstone Buttes. This is due mainly to the fact that our route lay along the divide, where water is scarce. It was the intention of the party to take the Bad River road, and they would have done so had they not been informed that everything was pastured closely all the way. Blue grama (*Bouteloua oligostachya*) makes a fine growth here and was nice and green the 1st of September. Considerable hay was being put up in the eastern portion of the region. It consisted principally of Western wheat-grass (*Agropyron spicatum*) and blue grama (*Bouteloua oligostachya*), together with some feather bunch-grass (*Stipa viridula*) and needle-grass (*S. comata*). In the "draws" there is more of the *Agropyron* and less of the *Bouteloua*. In the larger draws there is a good growth of big cord-grass (*Spartina cynosuroides*) and on the knolls a light growth of big sand-grass (*Calamovilfa longifolia*).

At Pierre the cattlemen were much exercised over the fact that the grass on the range was so backward in ripening. They were fearful lest it should remain green until frost struck it, thereby leaving their winter feed in poor condition. They were therefore well pleased with the hot, dry weather which prevailed during the first ten days in September.

CULTIVATED GRASSES AND FORAGE PLANTS.

The failure of the ranges to supply sufficient forage for all seasons of the year has led to an increased effort on the part of the stockmen and farmers to cultivate the various standard grass and forage crops. In many instances experiments have been made with the different novelties introduced and sold by seedsmen or distributed gratuitously by the United States Department of Agriculture. As was to be expected, the old and so-called "tame" grasses have refused to accommodate themselves to the extreme conditions of soil and climate prevailing in some parts of the region, and while a few of the newly introduced plants have proved valuable, many others have shown themselves to be practically worthless. The "tame" grasses most commonly found in meadows and pastures are timothy, redtop, Kentucky blue grass, smooth or Hungarian brome-grass, meadow fescue, and orchard grass. The millets and the various small grains are quite generally grown for summer forage and for hay, and corn and the sorghums, both saccharine and non-saccharine varieties, are occasionally grown for fodder. Nearly all the

common clovers are successfully grown in some part of the region, alfalfa and red clover being in most general cultivation. Very few of the large ranches are without fields of timothy, redtop, clover, or alfalfa; often all are grown on the same ranch. Sometimes these fields cover hundreds of acres and yield thousands of tons of hay. Almost without exception they are irrigated, at least for a portion of the season. In many localities the proprietors of the large ranches prefer not to bother with the extensive cultivation of forage crops that would be necessary to properly feed their herds during the winter, depending upon the small ranchmen and farmers in the valleys for their winter forage supply. The hay is sold to the ranchmen, or more often the cattle are brought to the farmer and he winters them at so much per head. This winter feeding of range stock is becoming quite an industry and could, no doubt, be more generally practiced with advantage to both the large and the small ranch owner. Up to the present time winter feeding is largely, in fact almost entirely, confined to cows, calves, and bulls; the most of the stock being expected to "rustle" its living on the range except during very stormy weather, when a little hay may be fed.

TIMOTHY.

Phleum pratense.

This is more widely cultivated than any other "tame" grass in the eastern Rocky Mountain region. The cheapness of the seed, the ease with which a meadow can be seeded down, and the excellent quality of the hay make this grass a great favorite. In most localities irrigation is necessary to grow it successfully, but with plenty of water enormous yields are often obtained, particularly in the rich valleys in the northern part of the region. Reports of the successful cultivation of this grass have been received from every county in both Montana and Wyoming, and from nearly every county in Colorado, but always under irrigation except in some of the moister valleys in or near the mountains. Sage-brush lands when cleared, irrigated, and seeded to timothy make fine meadows, but the greasewood lands are too strongly impregnated with alkali. Timothy can be grown successfully at a higher altitude than most of the other commonly grown grasses, and is becoming quite generally established in waste places and along trails throughout the entire region. Several of the field agents of the division have reported finding it well established in many places in the mountains. Professor Pammel found it flourishing at an elevation of 10,500 feet in northern Colorado, and the writer found it at a similar elevation in the central part of the State. In the Bear Lodge Mountains and in the Black Hills it is very abundant at 5,000 and 6,000 feet, making a very fine growth, and is spreading very rapidly in moist, open situations along the trails. In the Big Horn Mountains of Wyoming and in the Spanish Basin in Montana it was found to be abundant, growing with alpine timothy (*Phleum alpinum* L.) at from

7,000 to 8,000 feet or more. This ability of timothy to establish itself and thrive at comparatively high altitudes makes it of special value for a large portion of this region. Speaking in this connection Mr. W. S. Coburn, of Delta County, Colo., says "timothy grows to perfection up to an elevation of 9,000 feet," and Mr. T. P. McDonald, of Carbon County, Mont., says "alfalfa and clover do well below the 4,500-foot level, but above that altitude timothy is the most successful."

REDTOP.

Agrostis alba.

This grass stands very close to timothy in its importance as a meadow grass for this region. Its cultivation is less general than that of timothy, however, being more strictly confined to the lower mountain valleys and better irrigated localities, and it is much more generally grown in Montana than in either Wyoming or Colorado. Like timothy, it is becoming well established in the native meadows and waste places. It thrives best on quite moist bottom lands, and is especially valuable on meadow lands liable to overflow. It is a common practice to sow this grass in irrigated native meadows to supplement the native species. It occupies the low marshy places and resists the encroachments of sedges and rushes better than timothy or the common native grasses. Though usually grown in connection with other grasses or with clovers, it makes a fine meadow when grown alone under proper irrigation. One of the finest redtop meadows ever seen by the writer was on a large horse ranch on the Gray Bull River, Wyoming. About 80 acres of the grass were standing at the time of the visit (August, 1897), and some had already been harvested. The land was the common sage-brush land of the valley, and had been given but little cultivation before being seeded down, but was well irrigated. The field was "as even as a floor," and as the mower passed along, it was noticed that the grass came well up along the sides of the horses. Almost all the cultivated land on this ranch was devoted to this crop, which is fed to fine-bred horses.

KENTUCKY BLUE GRASS.

Poa pratensis.

The principal use of Kentucky blue grass in this region is for lawns. With irrigation fine lawns can be made almost anywhere, if the land is not too strongly impregnated with alkali. The great difficulty often experienced in getting a good stand of this grass is one of the chief drawbacks to its culture here. The seed as sold in the markets is too often so poor that the farmer fails to get a good stand for his first sowing and gives up in disgust. Then, again, it takes some time for the grass to form a good sod, and the average Western farmer is too impatient for immediate results to wait for it. Nevertheless this grass is becoming quite abundant in many of the older settled localities and is gradually working its way into the meadows and pastures. Together

with Canadian blue grass (*Poa compressa*), low spear-grass (*Poa annua*), and redtop, it follows along the irrigating ditches, forming bright green borders, and affording many juicy mouthfuls for the cattle and other stock. Like most of the other cultivated grasses, it thrives best in the rich valleys of the lower mountains and foothills, where it is protected from drought and the excessive heat of midsummer. It is indigenous in many parts of the Rocky Mountain region.

SMOOTH OR HUNGARIAN BROME-GRASS.

Bromus inermis.

Of all recent introductions smooth brome (see fig. 6) is the most promising hay and pasture grass for the dry portions of the Northwest. Not only does it possess excellent drought-resistant qualities, but it starts much earlier in the season than the common grasses and continues growing well into the autumn, two things very much to be desired in a grass for cultivation in this region at the present time.

FIG. 6.—Smooth or Hungarian brome-grass (*Bromus inermis*): *a*, spikelet; *b*, flowering glume seen from the back; *c*, floret seen from the anterior side, showing palea.

In Colorado the grass has been tried in a number of localities with good success. In speaking of grasses for dry situations on the ranges, Mr. R. E. Beatty, of Arapahoe County, says, "*Bromus inermis* comes the nearest to a suitable grass that we have tried so far;" Mr. Thomas R. Pace, of Garnett, "recommends smooth brome-grass," and Mr. George C. Baker, of Mosca, says, "*Bromus inermis* is our best tame grass." It is regarded as the most promising of the introduced grasses tried at the Colorado experiment station. The grass seems to have been given less attention in Wyoming than in either Colorado or Montana. Mr. Griffiths, in his report for the past season, speaks of seeing a plot of it on the ranch of Mr. John Baugh, of Carlisle, Wyo. He says,

"Mr. Baugh has been experimenting two years, both with and without irrigation. He seems to think that the smooth brome-grass does not thrive so well under irrigation. The effect of irrigation was really quite peculiar. The irrigated portion of the plot was fresh and green (middle of August) while the unirrigated portion, though it had made a much better growth, was completely dried up. I am not certain but that a thorough wetting at less frequent intervals would have produced better results. He irrigates by means of a tank and windmill. The water is conducted to the garden by a pipe and the crop is sprayed. All his garden truck looked well. Cabbage and tomatoes were especially fine." In Colorado smooth brome has done well under irrigation, particularly when pastured.

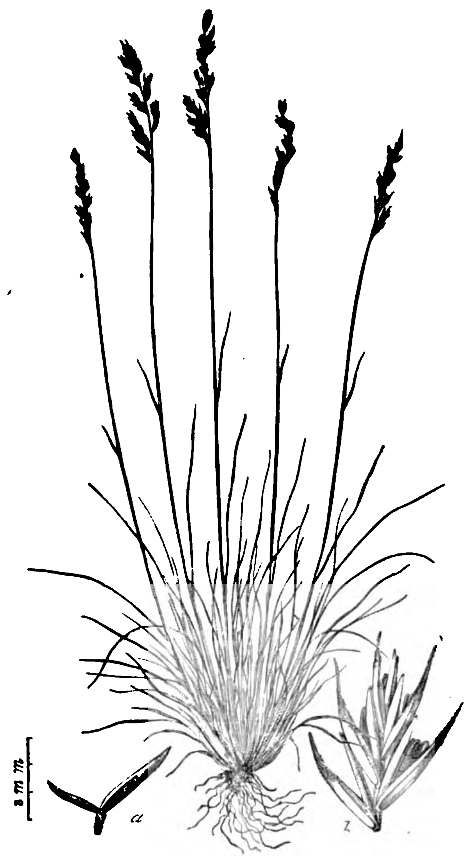

FIG. 7.—Sheep fescue (*Festuca ovina*).

In Montana smooth brome has received considerable attention, and reports regarding it are very satisfactory indeed. Hon. Paris Gibson, of Great Falls, says, "In the experiments I have made with new forage plants I find *Bromus inermis* the most hardy. It appears in the spring much earlier than our native grasses." Similar reports were received from Messrs. M. W. Jones and E. Vine, of Miles City, and from Director Emery of the State Experiment Station. Judging from these reports and from the excellent results already obtained in growing this grass in Canada, as well as in the Dakotas and other Northwestern States, it seems probable that smooth brome will prove of great value for cultivation on the dry lands of the Northwest. It should be given a thorough trial, especially as a grass for reseeding worn meadows and pastures.

THE FESCUES.

About the only fescue that seems to have been tried to any extent is meadow fescue (*Festuca elatior pratensis*), and this is only occasionally seen in cultivation—usually in mixture with other grasses or with

clovers. On rich loamy soils, with abundant irrigation, it seems to do quite well. Favorable reports have been received from several points in central Colorado and central and southern Montana. Mr. Griffiths found it doing well in northeastern Wyoming. It is frequently met with along irrigating ditches and in public parks in the cities and towns, often occurring in waste places as an escape and already well established in favorable situations. It does not seem to thrive in soils containing much alkali. At the Utah Station this grass has been grown with fine success as an element in permanent pastures and meadows, and it is altogether likely that it can be so used in many portions of the Rocky Mountain region. Many native forms of both sheep fescue (*Festuca ovina*) (fig. 7) and red fescue (*Festuca rubra*) occur in this region, and although the cultivated varieties have been given little, if any, attention, it is not unlikely that they could be used to advantage in reseeding the ranges, particularly in the foothills and lower mountains.

ORCHARD GRASS.

Dactylis glomerata.

Like meadow fescue, this grass has received but little attention from farmers and ranchmen in this region. It has been tried at the experiment stations, sometimes with success and sometimes without. It requires fairly rich soil and a reasonable amount of moisture, and hence thrives best on irrigated lands of the valleys and benches. It has succeeded quite well at the Utah station, and good reports of it have been received from central and southern Montana and from many parts of Colorado. It was seen on several ranches near Evanston, Wyo., the past season and was making a fine growth. Mr. W. C. Burke, of Las Animas, Colo., in an answer to the question as to what grasses and forage plants do best in his locality, includes this grass, with the statement that "when irrigated it produces about 2 tons of hay per acre." It is deserving of more general cultivation as an element in mixtures for permanent meadows and pastures and for seeding down sparsely wooded areas.

ALFALFA.

By far the most important forage plant cultivated in this region at the present time is alfalfa. Scarcely a farm or ranch under irrigation can be found in the entire region without its alfalfa field, and on many of the larger ranches hundreds of acres are devoted almost exclusively to this crop. It flourishes on the better drained valley lands and irrigated bench lands in all parts of the region where the altitude is not too great, and alfalfa hay constitutes the principal winter feed for many thousand head of horses, sheep, and cattle. Of recent years it is being extensively used in fattening sheep and cattle for market. There is great need of a good supplementary forage to be fed along with the alfalfa. It is so rich in muscle-making food elements that, as ordinarily

fed, its full value is not obtained, and ranchmen are beginning to realize the necessity of mixing it with corn fodder, sorghum, prairie hay, or other forage containing an excess of fat-forming elements in order to feed in the most economical manner.

Three or more cuttings are obtained each season unless, as is often the case, it is more desirable to pasture off the later growth. This is done when summer pasturage is scarce or when there is no market for the hay and the ranchman gets enough for his own use from the first one or two cuttings. During the past season it was learned from several ranchmen in the Big Horn Basin that they very seldom made more than two cuttings, for the reason that they needed no more for wintering their own stock and the price of the hay was so low that it paid them better to pasture their fields for a portion of the season. This was in a region where the summer pasturage was short because of drought and previous overstocking, though at the present time the number of stock kept on the range is undoubtedly much below what the land ought to support under a proper system of grazing and supplementary feeding.

One of the things which makes alfalfa so valuable for this region is its ability to thrive on land containing a considerable quantity of alkali. There are few cultivated crops that will stand as much alkali as this.

The injurious effects of too much water upon the growth of alfalfa is well illustrated by the conditions at present prevailing in a number of localities in Colorado, particularly in the southern part of the State. The soil, either from natural causes or as a result of the methods of irrigation practiced, has become saturated with water to within a short distance of the surface. As a consequence the roots of the alfalfa rot and the plants become sickly and finally die, rendering it impossible to produce anything like a permanent meadow. Here in Colorado, as well as in many other parts of this region, the best success is obtained with alfalfa on the bench lands. It is surprising what a small amount of labor is required to obtain a good alfalfa meadow in some portions of this region. For example, it is a common practice to give sage-brush land no more plowing or other preparation than is necessary in taking off the sage-brush. The brush is cut and grubbed out, raked up and burned, and the seed sown directly on the unplowed land, covered and watered. The soil is so loose as to require little or no stirring, and water is the only thing necessary to make it produce abundant crops of alfalfa. Of course more thorough preparation will give an evener and more lasting meadow, but the writer has seen many fine alfalfa meadows on land untouched by the plow except to make ditches for distributing the water.

RED CLOVER.

Next to alfalfa, red clover is the most widely cultivated leguminous forage crop in this region. It seems to be more generally grown in

Montana than in either Colorado or Wyoming, and its cultivation is chiefly confined to rich valleys and bench lands near the mountains where there is a good supply of moisture or where irrigation is practiced. It is usually grown with timothy and other meadow grasses, and is cut for hay or used as a soiling crop. Very fine crops are raised in central and southwestern Montana and in northern and central Colorado, and it is occasionally seen elsewhere in these States. Red clover is not generally grown in Wyoming, though it is being tried in many localities with very fair success. During the past season it was observed in successful cultivation in Crook, Johnson, Bighorn, and Uinta counties.

ALSIKE.

Although less commonly grown than red clover, alsike is certainly a valuable crop for many parts of this region. Many farmers who have grown them side by side prefer the alsike to the red clover as a forage crop for their respective localities. For example, Mr. C. C. Willis, of Horse Plains, Mont., writes that he much prefers alsike on account of its heavier yield of forage and greater drought-enduring qualities. Excellent fields of alsike and timothy were seen in 1896 in the Gallatin Valley, and reports of the successful growing of this clover have been received from various points in central and southwestern Montana, northern Wyoming, and northern and central Colorado. As a general thing the alsike seems to be hardier than red clover and is better adapted for permanent meadows, and some maintain that it does better on the heavy "gumbo" soil found in so many places in the Northwest. It has also given good results in many parts of the Dakotas, where it has received a thorough trial. It deserves more attention from farmers and ranchmen in the Northwest generally.

WHITE CLOVER.

It is rarely that this clover is sown in this region except on lawns or in dooryards, but its ability to gain a foothold and maintain itself among other vegetation is well shown in the fact that it is found everywhere in patches of various sizes along the margins of irrigating ditches, in waste places, and in pastures and meadows. Reports from several counties in central and western Montana and central Colorado indicate that it is occasionally sown in pastures and is growing in favor, more particularly for use in pastures for sheep and dairy stock. In extended trips through this region in both 1896 and 1897 the writer found but very few instances of its having been sown purposely in pastures, though it was often present even in native pastures in greater or less quantities.

The excellent showing made by this clover during the season of 1897 was very noticeable throughout the West and Northwest generally, particularly in the older-settled districts. In eastern South Dakota, northwestern Iowa, and eastern Nebraska this clover made a remark-

able development. Almost everywhere along roadsides, in waste places, and in pastures could be seen the masses of white blossoms. Pastures in which scarcely an appreciable amount of the clover had ever been observed before were white with it. In many cases no clover seed has ever been sown in the pastures, but it has gradually worked in from accidental sources, and though the progress has undoubtedly been slow, it has nevertheless been sure, and this clover has come to occupy a very important place among the vegetation of the pastures. The tendency of white clover to develop in alternating periods of light and heavy growth has often been observed in the past, and its appearance in such quantity in the present instance is a good illustration of the changes in the composition of pastures that are going on constantly, though they are not always for the betterment of the pasture, as in this case.

MISCELLANEOUS FORAGE CROPS.

Aside from the preceding list of standard grasses and forage plants, there are a number of crops of greater or less importance that are grown in the various parts of the region. In most cases their cultivation is not general, sometimes because the plants are not well enough known and sometimes because of their inability to thrive under the conditions prevailing over a large part of the region.

In the dry portions of Colorado where irrigation is not practiced the sorghums, both saccharine and nonsaccharine varieties, are grown to some extent for winter forage and for soiling. The great drought-enduring qualities of the sorghums and their ability to thrive on land containing considerable alkali render them especially valuable for certain portions of this region. Mr. E. E. T. Hazen, of Phillips County, Colo., reports good success in growing several of the nonsaccharine varieties (yellow milo maize, brown doura, and Jerusalem corn), and S. Needham, of Prowers County, regards "sorghum as very valuable for winter forage on nonirrigable lands." Only the early maturing varieties like Early Amber are grown in Wyoming and Montana, and these not to any great extent.

The common cereal crops, such as rye, oats, wheat, and barley, are often grown for forage. Rye and oats are used for this purpose more often than any others, although it is a common practice to cut any cereal for hay if conditions are such that it is not likely to mature a crop of grain. Rye is being very successfully grown for late and early pasturage in many localities, and its cultivation is becoming more general each year. It is already quite extensively grown in central Colorado, northern Wyoming, and some parts of Montana. Sown in early autumn, it gets the benefit of the rains and snows of fall, winter, and early spring, and usually matures a fair crop of grain in addition to furnishing much pasturage, when spring-sown crops would fail unless artificially watered.

Other crops that have been grown in some parts of the region with success are field peas, rape, sand or hairy vetch, and esparcette. Par-

ticularly encouraging results are reported from central Colorado regarding the growing of field peas for forage, and the crop has done well in many other parts of the region. Profitable crops of rape, vetch, and esparcette are reported from Montana and elsewhere.

Millet is more generally grown for hay than any other annual. Common millet and Hungarian are usually preferred for the average uplands. Broom-corn millet is sometimes grown as a grain crop, but yields too lightly for a hay crop where the better varieties can be grown. As a general rule all the millets are used as "catch crops" rather than as regular crops, and as such they fill an important place in northwestern agriculture. They are most commonly grown in the northern part of the region.

NATIVE GRASSES AND FORAGE PLANTS.

There are about 270 species and varieties of grasses known to be indigenous to this region. Naturally a great majority of these are too small or too rare to be of much importance in the production of hay or pasturage. The most valuable species are quite widely distributed, although occasionally a species of but local occurrence may be of considerable importance in its particular locality, as is the case with some of those occurring in the mountains.

The great economic importance of the native grasses is at once apparent when one recalls the many thousands of sheep, cattle, horses, and mules that are raised in this region, and that depend entirely upon the native grasses and forage plants for subsistence for from eight to twelve months of the year. That the quality of the forage afforded is excellent is shown by the fact that most of the vast numbers of fat cattle and sheep annually shipped to the Eastern markets from this region receive no other food than that furnished by the natural meadows and pastures of the ranges.

From the economic point of view the important native grasses of this region may be classed into two groups, namely, meadow grasses and pasture grasses. To be sure, no hard and fast line can be drawn, but as a general thing the best pasture grasses are of little use for hay, and within late years, at least, wherever good hay-producing grasses occur in any great extent, they are fenced off from the open range and preserved for winter forage.

NATIVE MEADOW OR HAY GRASSES.

LOWLAND MEADOWS.

The grasses most abundant in the meadows at the lower altitudes are usually quite different from those which predominate in the mountain meadows, although it is seldom that any sharp line occurs where the strictly mountain grasses begin and the lower valley grasses leave off. The change is rather a gradual one. Hay meadows are almost entirely

confined to the valleys of the larger streams, the prairies and hilly country being given over to grazing. Occasionally a rich plateau or "bench" may be found with a sufficient supply of moisture to produce a growth of grass luxuriant enough for hay, but these are rare. The grasses of most importance in the meadows in the lower valleys are wheat-grasses (*Agropyron* spp.), meadow-grasses (*Poa* spp.), manna-grasses (*Panicularia* spp.), sand-grasses or blue-joints (*Calamagrostis* spp.), and wild rye-grasses (*Elymus* spp.).

FIG. 8.—Slender wheat-grass (*Agropyron tenerum*).

Of these the wheat-grasses are by far the most valuable. A great many species occur in this region, but there are three which are of special importance as hay-producing grasses. These are Western wheat-grass (*Agropyron spicatum*), known also as Colorado blue-stem, slender wheat-grass (*Agropyron tenerum*) (see fig. 8), and false quack-grass (*Agropyron pseudorepens*). These grasses are very generally distributed over the region, and grow naturally on a great variety of soils. All respond readily to cultivation. Usually all that is necessary to convert a piece of good sage-brush or valley land into a wheat grass meadow is to clear off the brush and large stones, keep off the stock, and water the land. The grasses will soon take complete possession. On nearly every well-kept ranch in the eastern Rocky Mountain region can be seen fine natural meadows made in this manner. Western wheat-grass is usually more abundant than either of the other sorts, and it is not an uncommon thing to see a meadow of 40, 80, or more acres composed almost exclusively of this grass. Without irrigation it is rarely possible to cut more than one crop in two years, as the grass requires time to recuperate. Even with irrigation it is seldom possible to obtain good crops for many consecutive years without cutting up the sod to overcome its "hidebound" condition and give opportunity for the growth

of new shoots. Under favorable conditions, however, these meadows may yield good crops for a number of years with nothing more than proper watering. Mr. Griffiths reports seeing a meadow of about 40 acres the past season, near Snoma, S. Dak., yielding a crop of about 2 tons of hay per acre, which had afforded a good crop for five consecutive seasons.

In the wet or boggy places in lowland meadows the wheat-grasses are replaced principally by the meadow-grasses and, if the soil is sandy, the sand-grasses or blue joints are often present in considerable quantity. Of these grasses reed meadow- or manna-grass (*Panicularia americana*) (see fig. 9) and nerved manna-grass (*P. nervata*) are common in very wet boggy places unless the soil is too strongly impregnated with alkali, when they are often replaced by alkali meadow-grass (*Puccinellia airoides*). This last grass is usually quite rigid and wiry and grows in close bunches, but furnishes considerable forage in some localities. Often it is about the only grass to be seen among the sedges and rushes of the wet, alkali meadows, and in such places it is more succulent and palatable than when growing in drier situations. It is very abundant in the overirrigated meadows along the Little Laramie River in Wyoming, and is quite widely distributed over the Western plains and throughout the valleys in altitudes below 8,000 feet.

FIG. 9.—Reed meadow-grass (*Panicularia americana*).

The true meadow-grasses (*Poa* spp.) are of much more value generally than those just mentioned. These are most abundant in the moist meadows near the foot of the mountains. Among the valuable kinds are the indigenous forms of Kentucky blue grass (*Poa pratensis*), the "bunch-grasses" (*Poa buckleyana*, *P. laevigata*, and *P. lucida*), Wyoming blue grass (*P. wheeleri*), bench-land spear-grass (*P. arida*), woodland meadow-grass (*P. nemoralis*), Nevada blue grass (*P. nevadensis*), and fowl meadow-grass or false redtop (*P. flava*). Many of these are of as much importance, under present conditions, for pasturage as for

hay, but with a proper supply of water all afford good yields of excellent hay. In the valleys Kentucky blue grass, in either its native or introduced form, is perhaps most commonly seen, and is becoming more and more abundant as the country is settled up and the native meadows brought under irrigation.

Of the "bunch-grass" *Poas*, *P. buckleyana* (fig. 10) is apparently the most widely distributed, being, if anything, more common on the dry uplands than in the valleys, and hence perhaps more properly to be regarded as a pasture grass. However, under irrigation it becomes less densely tufted, the leaves are broader and more luxuriant, and the yield of hay is good. Smooth bunch-grass (*P. lævigata*) and pale bunch-grass (*P. lucida*) are more often found in the lowlands and are excellent meadow grasses. They are most abundant in the middle Rocky Mountain region.

FIG. 10.—Bunch-grass (*Poa buckleyana*).

Wyoming blue grass is often found with Kentucky blue grass in moist meadows and along banks of streams, but it ascends higher up the mountains, where it is frequently abundant in open pine and spruce woods, sometimes occurring in dry situations, but generally where the soil is well supplied with moisture. It is especially abundant in parts of Wyoming and central Montana, usually occurring at an altitude of from 6,000 to 8,000 or 9,000 feet, but sometimes ascending to 10,000 feet. In the rich moist soil of "burn outs" in pine and spruce woods it makes a magnificent growth.

Bench-land spear-grass (see fig. 11) is quite generally distributed throughout this region. It usually occurs in rather dry meadows, often in patches of considerable extent, but never forming a close sod, as does Kentucky blue grass. The forage is of poorer quality than that furnished by the latter and the yield is lighter. However, the grass is one of the earliest of the native species and thrives better on dry soil than Kentucky blue grass. Under cultivation it would probably be more valuable for pastures than for meadows.

There are few of the native meadow-grasses that grow naturally under such a wide range of soil and climatic conditions as woodland meadow-grass in its several varieties. It is common in woodlands along the prairie streams, and follows up the valleys into the foothills and mountains, where it becomes an important element in the moist meadows. It also occurs on rocky hills and mountain sides, some of its forms flourishing at an altitude of 10,000 feet, or even more, in Colorado. Some of the forms growing in the rich lowland meadows approach fowl meadow-grass in size and appearance, and afford a large amount of excellent hay.

FIG. 11.—Bench-land spear-grass (*Poa arida*).

Nevada blue grass (fig. 12) is more common on the west side of the Continental Divide than on the east, but it is nevertheless sufficiently abundant in the latter region to form an important part of the vegetation in many of the natural meadows. It occurs as far east as the Pine Ridge of Nebraska and the Black Hills of South Dakota, but is most abundant in the valleys among the foothills and mountains. Some forms of it grow on rather dry soil in open woodlands and on rocky mountain sides. It prefers rich soil with a medium supply of moisture and does well under irrigation. Under favorable conditions it makes an excellent growth of leaves, and yields a large amount of hay compared with most of the native species of *Poa*. It is rarely found above an altitude of 8,000 or 9,000 feet in this region.

Fowl meadow-grass is not as abundant in the immediate vicinity of the mountains as it is farther to the eastward, but nevertheless is found quite plentifully in certain localities. It occurs most frequently along streams about the edges of thickets, and on moist banks and bottom lands subject to overflow in the early part of the season. For such places it is a valuable grass, making a good yield under conditions that would "drown out" most of the common grasses. It is much more valuable for hay than for pasturage. In some localities this grass is called false redtop.

The sand-grasses or blue joints found in the meadows are remarkable for their abundance of long root-leaves and the consequent large yield

of hay, which is usually of an excellent quality. One of the most widely distributed species is the common blue joint (*Calamagrostis canadensis*), locally known as false or native redtop. This grass is often very abundant in moist, sandy river bottoms, and some of its many forms ascend well up into the mountains. It has been cultivated with good success and is worthy of extended trial in the Northwest.

Sand-grass or yellow-top (*Calamagrostis americana*) is also well distributed throughout this region. It is most commonly found along the sandy banks of streams, ponds, and lakes, often (especially along sloughs) forming a well-defined "yellow-top" zone of vegetation, noticeable from a considerable distance because of the characteristic color of the grass. It seems to thrive better in alkali soils than its relatives, and is generally confined to comparatively low altitudes.

Big sand-grass (*Calamovilfa longifolia*), although common on the plains and in the valleys throughout, is not so valuable as the preceding species because of the very coarse and fibrous nature of the forage which it produces. It is most commonly found in dry, sandy swales and on sandy hillsides, and in the bad lands and other dry districts, where the better grasses are scarce, it is often plentiful. In such localities it is regarded as a valuable grass, and is used for hay.

FIG. 12.—Nevada blue grass (*Poa nevadensis*).

There are several of the wild rye-grasses that occur in sufficient quantities to be of importance in the vegetation of the native meadows. All are most abundant as a rule in rich, open, rather dry meadows and on hillsides, and are rather coarse, harsh plants, affording considerable hay of an average quality. The kinds of most importance are common wild-rye (*Elymus canadensis*), Macoun's rye-grass (*E. macounii*), and giant rye-grass (*E. condensatus*). The first of these is the most generally distributed, and is probably the most valuable, although the second, which is also quite common, is a finer grass and produces a better quality of hay.

Giant rye-grass is a tall, coarse species, growing in large clumps, found in sandy or gravelly soil of meadows and hillsides. It is too harsh and woody to be relished by stock, and is seldom eaten except when young, or in winter, when other forage is scarce or when the snow is deep. Owing to its habit of growing in such dense bunches it is difficult to cut for hay. However, when better grasses are scarce it is frequently cut early, and the hay is said to be of fair quality. When a meadow becomes thickly seeded to this grass and is cut or burned closely for several seasons a fairly even sod is produced, and such a meadow is of considerable value, particularly when, as is usually the case, the better grasses can not be grown because of adverse soil or climatic conditions. Such meadows are much more common on the west side of the Continental Divide than on the east. During the summer of 1896 a number of such meadows were seen in southwestern Montana and eastern Idaho, and in 1897 several were seen in northwestern Wyoming. This grass usually ripens a large amount of seed, and stock gets a great deal of nourishment by eating the seed-heads in fall and winter. Horses are said to be particularly fond of them.

On the eastern edge of this region Virginian lyme-grass (*Elymus virginicus*) is quite common in some localities, but is more valuable for early pasturage than for hay.

Among other native grasses that may be mentioned as of value in native meadows, but which only occasionally occupy any prominent place in them, are bearded wheat-grass (*Agropyron richardsoni*), in rather dry meadows; the cord-grasses (*Spartina cynosuroides* and *S. gracilis*), in sloughs and low places, the latter in alkali situations, particularly; slough-grass or wild timothy (*Beckmannia erucæformis*), along sloughs and irrigation ditches and in wet meadows, becoming very abundant in many parts of the region; and reed canary-grass (*Phalaris arundinacea*), abundant in places, and particularly valuable in wet meadow lands and sloughs.

MOUNTAIN MEADOWS.

The mountain meadows, so numerous in portions of this region, differ considerably in the composition of their vegetation from those of the lower valleys and plains discussed in the previous pages. Here the true meadow-grasses form the predominating element, replacing the wheat-grasses of the lower meadows; the brome-grasses (*Bromus* spp.), seldom seen at the lower altitudes, are here abundant; the tussock-grasses (*Deschampsia* spp.) are plentiful everywhere in wet, boggy situations; and the blue joints (*Calamagrostis* spp.), alpine timothy (*Phleum alpinum*), mountain foxtail (*Alopecurus occidentalis*), the wild oat-grasses (*Danthonia* spp.), rough-leafed bent (*Agrostis asperifolia*), and red fescue (*Festuca rubra*) are all valuable members of the vegetation of these meadows.

Of the blue grasses (*Poa* spp.) several of those mentioned in the foregoing discussion are common in the mountain meadows, namely, Wyo-

ming blue grass (see fig. 13), smooth bunch-grass, Nevada blue grass, and woodland meadow-grass. In the higher altitudes alpine blue grass (*Poa alpina*) and mountain meadow-grass (*Poa leptocoma*) are the predominating species. An interesting thing in connection with the distribution of these two grasses was observed in northern Wyoming the past season. In the Bear Lodge range, in northeastern Wyoming, alpine blue grass was frequently met, and it was also very abundant in the mountains at the head of Meeteetse Creek in the northwestern part of the State, but extended search failed to reveal any of this grass in the Big Horn Mountains in the north central part of the State and nearly midway between the other two localities. Mountain meadow-grass was very abundant in the Big Horn Mountains, and was also found in the mountains at the head of Meeteetse Creek, but was not seen in the northeastern part of the State. Alpine blue grass is most abundant in sandy or gravelly soil near the streams, and mountain meadow-grass prefers cold, wet, boggy meadows and mountain sides.

FIG. 13.—Wyoming blue grass (*Poa wheeleri*).

Alpine timothy is very widely distributed at the higher elevations in the Rocky Mountain region. It is quite abundant in the Black Hills above 6,000 feet. In the Big Horn Mountains it vies with tussock-grass for first place in many of the meadows at 7,000 to 8,000 feet, particularly on the western side of the range, where it is much more abundant than on the eastern slope. In central Montana it is most plentiful at and above 6,500 feet, rarely occurring below 6,000 feet, the ordinary limit for common timothy. It is rarely found below 9,000 feet in Colorado, except, perhaps, in the northern part of the State, but is plentiful up to 13,000 feet. Hay made from this grass is highly prized by ranchmen, especially for horses.

Mountain foxtail (fig. 14), which is also sometimes called mountain timothy, has much the appearance of true mountain or alpine timothy, but is usually more robust and of a softer texture and produces a better looking hay, much like that from the cultivated meadow foxtail (*Alopecurus pratensis*), which this grass resembles in habit of growth. Although found throughout the Rocky Mountain region, and having similar altitudinal limits, it is much less common as a rule than alpine timothy. It is abundant in the rich, moist meadows of the Spanish Basin and elsewhere in southwestern Montana, and makes a remarkably luxuriant growth, frequently reaching a height of three or four feet, and is one of the most promising of the native grasses for cultivation in meadows at the higher altitudes.

FIG. 14.—Mountain Foxtail (*Alopecurus occidentalis*).

Several of the native brome-grasses are of great value in the native meadows at an altitude of from 5,000 to 8,000 feet in Wyoming and Montana and from 6,000 to 9,500 in Colorado. The most valuable of these brome-grasses are short-awned brome (*Bromus breviaristatus*) (see fig. 15) and Western brome (*Bromus pumpellianus*). Both are coarse-growing perennials and occur throughout the Rocky Mountain region, chiefly in the rather dry valleys and "parks;" the former selecting the moister situations and the latter the drier ones. Although they are often found growing together, Western brome-grass seems to have a somewhat higher altitudinal limit, its point of best development usually ranging from 500 to 1,000 feet above that of short-awned brome. The latter is occasionally abundant down as low as 4,000 feet in central Montana, while the former is but rarely found at that altitude. In northern Wyoming short-awned brome is most abundant at from 5,000 to 7,000 feet and Western brome at from 6,000 to 8,000. Both of these grasses have been cultivated in some parts of the Northwest with success and promise to be valuable for meadows at high altitudes. Western brome has very much the same appearance and habit of growth as

the recently introduced smooth or Hungarian brome which is being grown with such excellent success in the semiarid West and Northwest.

Tussock-grass (*Deschampsia cæspitosa*) is perhaps the most abundant and widely distributed grass in the native meadows of the Rocky Mountain region. It has a very wide altitudinal range. For example, it is abundant in wet meadows in the Gallatin Valley about Bozeman, Mont., at an altitude of about 4,000 feet, and ascends to above the timber line in the mountains on either side of the valley. On account of its tufted habit of growth it does not form an even sod, and hence does not make a good meadow by itself. In most instances, however, it is accompanied by other grasses, such as the true meadow-grasses, redtop and blue joint, which fill in the spaces between the tufts, making a fairly good meadow sod. Some observers have reported this grass as of no practical value for either hay or pasturage, but such statements are not borne out by the reports of our field agents nor by the opinions advanced by the ranchers.

FIG. 15.—Short-awned Brome-grass (*Bromus breviaristatus*): *a*, the floret seen from the side; *b*, palea; *c*, joint of the rachilla; *d*, grain; *e*, lower portion of pistil, showing lodicules; *f*, young seed or grain.

While neither the yield nor the quality of the forage is equal to that obtained from timothy or redtop, there can be no doubt that the grass fills an important place among the native meadow and pasture grasses of this region. It flourishes in wet, boggy places where many of the better grasses can not grow, and by its dense tufts of tough fibrous roots helps to convert these bogs into usable meadow lands. Moreover, continued mowing and pasturing have the effect of reducing these tufts materially, so that with a few other grasses to act as fillers a comparatively even sod is produced. Such a condition of things may be seen in many of the mountain valleys, as, for example, in the valley of the Little Laramie River near Sheep

Mountain. In the varieties of tussock-grass growing in the higher altitudes the leaves become considerably reduced, and, of course, produce little forage of any sort, but the varieties growing in the meadows at from 4,000 to 6,500 feet develop a much greater leafage and afford a large amount of hay and pasturage.

A form of red fescue is not uncommon in the moist meadows at from 4,000 to 9,000 feet altitude in the northern part of the Rocky Mountain region, and is of much value for hay in some localities. It seldom forms tufts of any size, spreads by means of very slender underground stems, and is usually found mixed with other grasses. It is quite abundant in the Spanish Basin and elsewhere in southwestern Montana, and also in the Big Horn and Shoshone mountains in Wyoming.

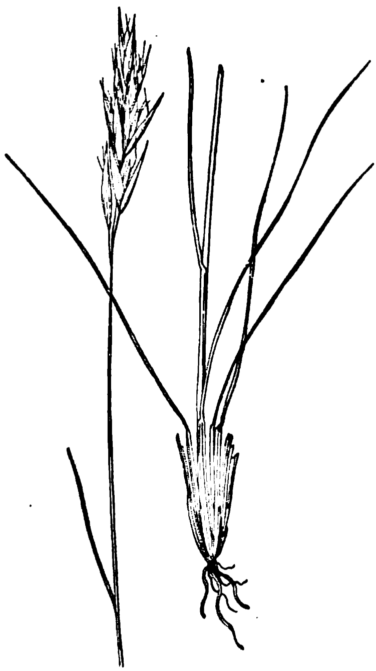

FIG. 16.—Rocky Mountain oat-grass (*Danthonia intermedia*).

Rough-leafed bent occurs naturally in wet, boggy meadows and along banks of streams and ditches. The best hay-producing forms occur at elevations of from 4,000 to 6,000, or occasionally 7,000, feet. This grass produces an abundant leafage, much more than the common redtop, and also produces a large amount of seed—two things very desirable in a grass for cultivation. In the wild state it seems to be even more hardy than redtop, and while flourishing best with plenty of water it will, nevertheless, endure considerable drought when once firmly established. It is quite an important element in the native meadows in portions of northern Wyoming and central and southern Montana, and is perhaps more common on the west side of the Continental Divide than on the east. As ordinarily seen in the natural condition, rough-leafed bent has a closely tufted habit of growth, but when thickly seeded, as when in cultivation or occasionally in native meadows when conditions are favorable, this habit is largely lost, and a fairly even sod is formed. Its good qualities as a meadow grass commend it to those experimenting with our native species. It will doubtless be found to be better adapted for meadows at higher altitudes than most of the common so-called tame grasses.

There are several of the oat-grasses found in greater or less abundance in the meadows and "parks" of the mountains and foothills of

this region. The most important are Californian oat-grass (*Danthonia californica*), Rocky Mountain oat-grass (*Danthonia intermedia*) (see fig. 16), and Parry's oat-grass (*Danthonia parryi*).

As a rule these oat-grasses occur naturally in rather dry meadows and on mountain sides, Californian oat-grass being more inclined to seek moist situations than either of the others. It is the largest of the native oat-grasses, reaching a height of 3 feet under favorable conditions, and is also the most abundant Northwestern species. In northern Wyoming and Montana it forms a considerable portion of the meadow vegetation at from 5,500 to 8,000 feet. It is occasionally found as low as 5,000 feet, but is most abundant at from 6,000 to 7,000 feet. On rich, irrigated meadows it makes a very fine growth. It is rarely found as far south as Colorado, where it is replaced by Parry's oat-grass.

Rocky Mountain oat-grass is often found growing along with Californian oat-grass; but it is a smaller plant, preferring rather drier soil and having a somewhat higher altitudinal range—seldom occurring below 7,000 feet, abundant at 8,000 to 10,000 feet, and ascending to 11,000 feet or even 12,500 feet in Colorado. It is probably of more value for pasturage than for hay.

Parry's oat-grass is most abundant in the park region of Colorado, but also occurs in southern Wyoming. Although occurring naturally in rather dry meadows and on mountain sides, it makes a fine growth under irrigation and is occasionally found in some quantity in timothy meadows. It has a much more tufted habit of growth than Californian oat-grass and its altitudinal range—from 7,000 to 10,000 feet—corresponds very well to that of its more northern relative. Although of local occurrence it is abundant in places, sometimes almost completely occupying the open woods and parks in the mountains of central Colorado.

The blue joints are usually conspicuous elements in the vegetation of the moister mountain meadows. They are the chief grasses in many of the deer parks in the higher mountains, and are particularly abundant in the wet, boggy, open aspen thickets so frequently found in the Northwest. There are about a half-dozen species which are found in sufficient quantities to be of importance as forage producers. By far the most abundant is mountain blue-joint (*Calamagrostis canadensis acuminata*), a near relative of the common blue joint, which it replaces in the higher altitudes. It produces a large amount of excellent hay in the wet, sandy or gravelly valleys along the mountain streams, and usually occurs at an altitude of from 5,000 to 8,000 feet in the North, but ascends to 10,000 or rarely to 11,000 feet in Colorado. In northern Wyoming and central and southern Montana it makes an enormous development in the rich, moist soil of some of the mountain parks, frequently covering areas several acres in extent with a dense growth, reaching a height of 3½ or 4 feet.

Northern blue joint or Langsdorff's reed-bent (*Calamagrostis langsdorffii*) is often found growing along with mountain blue joint and has a

similar range, but is much less abundant and has rather higher altitudinal limits. In localities where it is plentiful it is highly prized by stockmen, by whom it is often called "purpletop" on account of the prevailing color of the inflorescence. It is much more common to the northward, being but rarely found as far south as Colorado, and then only in the higher mountains.

Other blue joints deserving special mention are Scribner's blue joint (*Calamagrostis scribneri*) and Suksdorf's blue-joint (*C. suksdorfii*). Both are northern in distribution, the latter being found in this region only in central and western Montana and most abundant west of the Continental Divide, and the former reaching down into central or rarely into southern Wyoming and Colorado. Both have an altitudinal range of about 3,000 feet, seldom occurring below 5,000 feet or above 8,000 feet in Wyoming and Montana. Suksdorf's blue joint, although reaching its best development in the moist land of the valleys, is often found on the drier ridges and mountain sides.

NATIVE PASTURE GRASSES.

Naturally much the greater portion of the grass land is used for grazing. At the present time nearly all the land not under irrigation is used for this purpose. This includes by far the larger part of the upland prairies, the bad lands, the broken foothill country, and the accessible mountainous country.

Some of these pasture lands, notably those in the mountains and higher foothills, can be used during only a portion of the year, but the remainder are grazed through the entire year. In some localities certain portions of the range are protected during the growing season in order that the grass may make a good growth and furnish forage for fall and winter grazing. Sometimes the stock is kept from these areas by fencing, but often the ranchmen, by common consent, keep the stock on other ranges during the summer, and bring it to the protected areas only when forced to do so by the approach of severe winter weather. In localities where the meadow lands and winter pastures are fenced in, the open range is usually in very bad condition. Every ranchman is eager to get his "share" of the open and free range, and naturally turns out all his stock during the summer. As a result, the grasses and better forage plants are eaten up or trampled into the ground before the end of the season. What wonder that the grasses are dying out on the open range! The wonder is that they have survived as long as they have. During the past season, while making wagon trips through the Belle Fourche and Big Horn Basin countries, it was often necessary to drive many miles in order to find sufficient pasturage for the team. All the grass lands not under fence were picked bare in July and August, and it was impossible to get feed along the trail except by obtaining permission of the ranchers to camp inside the inclosures. Of course the grasses are being pre-

served within the fenced areas, but these compose but a relatively small part of the total pasture lands, and the get-all-you-can system is rapidly and certainly ruining the open range. In parts of the range region the scarcity of stock during the past few years, together with a few favorable growing seasons, has allowed the grasses to recuperate somewhat, but already the stockmen are beginning to increase their herds in order to be able to take advantage of the anticipated rise in prices of beef cattle, mutton, and wool, and there is danger that those lands not already overstocked will soon be so unless something can be done to convince these stockmen of the shortsightedness of such a policy.

In the higher foothills and mountains the pasturage is generally in good condition—much better than on the prairies. There are two principal reasons for this. In the first place, there is usually a good supply of moisture, and in the second place, the lands can be grazed during only a portion of the year on account of the heavy snowfall. As the lands can be grazed for but four or five months of the year at the outside, there is a long period during the early part of the season when the grasses make a considerable growth, so that they are already well along in the season's development, sometimes maturing seed, before grazing begins.

GRASSES OF THE PLAINS.

Out on the open ranges of the plains, however, there are few localities in which the pasturage is anything like as good as in former years. Leading stockmen from nearly all parts of the plains region estimate that the stock-carrying capacity of the pasture lands has been reduced on the average from 40 to 50 per cent in the last ten or fifteen years. The real reason for this is overstocking. The real stock-carrying capacity of a given area of pasture lands is the amount of stock that can safely be grazed on it during a dry or unfavorable season; and if these lands are to be kept in proper condition this limit should never be exceeded except perhaps temporarily during particularly favorable seasons; and the number of stock should be reduced as soon as it is seen that the grasses are being grazed too closely. Under the present system, or rather lack of system, of controlling the open grazing lands, it is hardly to be expected that the ranchman will do otherwise than to continue to try to get his "share" of the forage on the open range, and in so doing will continue to add to its already overburdened condition.

There are many thousands of acres of the public lands in this region that are of more value for grazing than for any other purpose, and in view of their importance and of the great danger of permanent injury resulting from the present methods of grazing it would seem urgent that some rational system of controlling them should be devised and adopted at once.

All the native grasses are grazed by stock to a greater or less extent, but many kinds are too small to afford much forage; others are too

coarse and woody, or otherwise unpalatable, to be of much value; and still others, while affording nutritious forage, are of most value for hay, and have been considered in the preceding pages of this report under the discussion of the native meadow-grasses.

The principal pasture grasses of the dry plains region are the gramas (*Bouteloua* spp.), buffalo-grass (*Bulbilis dactyloides*), wheat grasses, already discussed under meadow-grasses, prairie June-grass (*Koeleria cristata*), and needle-grasses (*Stipa* spp.). Other grasses of considerable value for grazing, but of more or less local distribution, are Indian millet (*Eriocoma cuspidata*), rush-grasses (*Sporobolus* spp.), Montana sand-grass (*Calamagrostis montanensis*), salt-grass (*Distichlis spicata*), and several of the bunch-grasses and wild ryes already mentioned.

FIG. 17.—Blue grama (*Bouteloua oligostachya*): *a*, empty glumes of a spikelet; *b*, spikelet with the empty glumes removed.

There are three gramas found in this region, and all are valuable pasture grasses. The best, and by far the most abundant, is blue grama (*Bouteloua oligostachya*). (See fig. 17.) It is one of the most generally distributed grasses of the prairies, and also occurs in considerable quantities on the higher bench lands and mesas, in the foothills, and in dry soil here and there in the lower mountain valleys. Everywhere it is regarded as an exceedingly valuable grass for both summer and winter pasturage, but particularly for the latter, vying with buffalo-grass for first place. At the present time it is probably of greater actual value on account of its more general occurrence, greater yield of forage, and greater ability to hold possession of the soil under excessive pasturing and extreme drought. In the rather loose, sandy soil, so common to the prairies of this region, blue grama forms closely sodded areas of varying extent which, on account of the purplish color of the foliage, stand out in strong contrast to the prevailing

pale color of the remaining grass vegetation. Often these areas may be found alternating with similar areas of the much paler buffalo-grass, and the checkerboard appearance thus given to the prairie is peculiarly striking. Although primarily a pasture grass, blue grama, under favorable conditions of soil and moisture, makes a fine growth of leafage sufficient to afford a good yield of hay of a very fine quality. Under ordinary conditions, however, this grass cures so well on the ground that stockmen prefer to use it for winter pasturage rather than go to the trouble of putting up the hay.

Black grama (*Bouteloua hirsuta*) is much more local in distribution than blue grama, to which it is very similar in appearance and habit of growth. It is confined largely to rather limited areas on sandy or gravelly knolls and hillsides, and is valuable chiefly because it thrives in these poor soils, furnishing considerable pasturage where but few other grasses can do more than simply exist.

FIG. 18.—Tall or side-oats grama (*Bouteloua curtipendula*): *a*, one of the short spikes; *b*, a spikelet; *c*, a spikelet with the outer empty glumes removed.

The third grama found in this region that deserves special mention is tall or side-oats grama (*Bouteloua curtipendula*). (See fig. 18.) It is a larger grass than either of the foregoing, and, while occurring throughout, is more abundant in the rich prairie soil of the eastern portion of the region. It produces a fine growth of long, slender leaves and on good soil makes a good yield of hay. In Nebraska and the Dakotas, where this grass is very abundant, it is regarded as of more value for hay than for pasturage, as it yields well, and the tough, rather harsh leaves are more readily eaten by stock as hay than when in the fresh state. In the principal range region, however, the grass is seldom present in much quantity, and on the drier soils the growth is not sufficient for hay; but it cures well on the ground and is readily eaten by range stock which are more accustomed to feeding on harsh herbage.

There is no other grass which has a reputation for excellence for both summer and winter pasturage equal to that of buffalo-grass. However, not all of the praise bestowed upon this grass really belongs to it, for the gramas are often confused with it, and to them, particularly to blue grama, belongs much of the credit given to buffalo-grass in many parts of the range region. In the minds of many ranchmen "buffalo-grass" includes blue grama and black grama as well as the true buffalo-grass (*Bulbilis dactyloides*), while in the minds of others grama or "grammer," as it is often pronounced, includes all three.

However, there is no doubt of the great value of the true buffalo-grass for pasturage. That it is one of the most palatable of native grasses is shown by the fact that, with plenty of other grasses on every hand, stock will keep it eaten close to the ground, and this is probably the reason that it is one of the first grasses to be killed out in overstocked ranges. It is reported to have practically disappeared from many places where it was formerly one of the commonest species, but while this is no doubt true of some localities, it is certainly not true of all. Examination has shown that it is still quite abundant in some of these localities, but is easily overlooked, as it is kept grazed so closely that it is seldom able to make enough development to show its characteristic habit of growth, much less to bloom and mature seed.

The wheat-grasses usually furnish a larger percentage of the pasturage on the prairies than is generally supposed. The most valuable varieties for grazing are provided with underground stems or rootstocks, which run along a short distance below the surface and at frequent intervals send up erect branches, either bearing only tufts of leaves or more rarely producing "heads." When too closely grazed, or during unfavorable seasons, much of the growth of the plant is made by these underground stems and very few, if any, fertile branches are developed. On this account many people have an idea that these grasses grow only once in every two or three years, when as a matter of fact the actual yield of forage may be almost as much for an "off" year as for any other. Although regarded primarily as meadow or hay grasses, the wheat-grasses furnish a large part of the pasturage throughout the entire range region, and on the more strongly alkaline soils are often the only grasses of any value to be found at all.

The needle-grasses (*Stipa* spp.) are among the most conspicuous members of the grass vegetation of the plains and lower mountains and foothills. All produce a relatively large amount of leafage, which makes an excellent quality of forage. During the late summer, when the seed is maturing, some of the needle-grasses cause much trouble and often severe injury to stock, particularly to sheep, as the sharp-pointed needles or "spears" work into the flesh of the animals, making painful sores and sometimes causing the death of the animal. In some of the best forage-producing species the "spears" are very blunt, and hence do little or no damage. Where the range is kept closely grazed the

plants seldom seed in sufficient quantity to be troublesome. As soon as the seed ripens the "spears" fall and work into the soil, so that these grasses can be used for hay or late grazing.

The common needle-grass (*Stipa comata*) of this region is valuable for both hay and pasturage. On poor rocky or gravelly soils, where it is one of the characteristic species (see fig. 19), it affords a large amount of pasturage, and on the rich prairie soils it makes a good yield of hay which is considered by many ranchmen to be equal in quality to "blue-stem" or wheat-grass hay. Here in the range region it takes the place of porcupine-grass (*Stipa spartea*), so abundant in the Lower Missouri Valley region, but which only occurs in any considerable quantity along

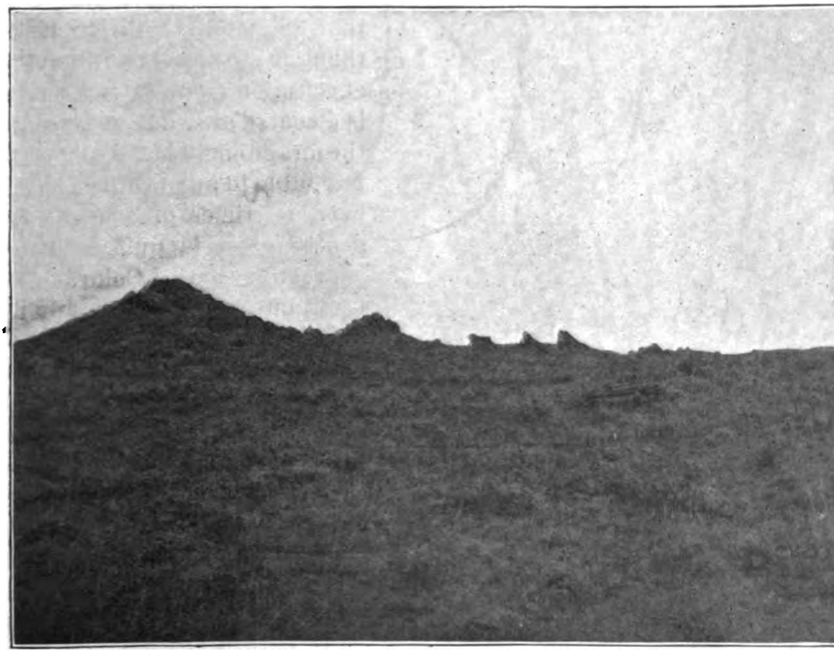

FIG. 19.—A bit of the "range" in N. E. Wyoming. (Photographed by David Griffiths.)

the eastern limits of the range. In some parts of the range, as for example in some localities of central and northern Wyoming, the common needle-grass sometimes composes the entire grass vegetation of the sage-brush prairies.

Another of the needle-grasses common in some of its many forms in this region is that most commonly known as feather bunch-grass (*Stipa viridula*). This is usually found in rather dry sandy soil, and forms dense tufted masses of leaves and stems, which afford good grazing. On account of its very blunt-pointed "spears" it seldom does any damage to stock and, as it endures close feeding well, it is one of the most desirable of the needle-grasses for grazing. Because of its densely tufted habit of growth and less luxuriant production of root leaves it is

of less value for hay than common needle-grass. Nelson's needle-grass (*Stipa nelsoni*) and purple-top needle-grass (*Stipa minor*) are also of value for pasturage, but both belong more properly, perhaps, to the higher altitudes. On the Big Horn ranges, at about 8,000 feet altitude, purple-top needle-grass is an important pasture grass and is also frequently cut for hay.

Fig. 20.—Prairie June-grass (*Koeleria cristata*): a, empty glumes; b, the two florets raised above the empty glumes.

Sleepy-grass (*Stipa vaseyi*) is quite abundant in the southern part of the eastern Rocky Mountain region. It takes its common name from the fact that in some localities it is thought to have a narcotic effect upon stock eating it. It is a coarse-growing grass, and the forage could hardly be very palatable in any event. However, in times of scarcity of pasturage it is quite closely grazed, in central Colorado at least, but whether with any ill effects has not been definitely ascertained. It is possible that the narcotic principle is not everywhere produced in injurious quantities.

One of the best early pasture grasses on the range is prairie June-grass (*Koeleria cristata*). (See fig. 20.) It is widely distributed, flourishes on a variety of soils, and is one of the earliest grasses to afford pasturage on the prairies. It has a tufted habit of growth and seldom exceeds a foot in height on the dry prairies, but in moist valleys it frequently reaches 2 feet or more and affords an excellent quality of hay. It matures its seed early and then dries up, furnishing but little fresh pasturage afterwards unless well watered. It usually seeds heavily. Stockmen regard it as one of the most valuable native pasture grasses because of its earliness and palatability. To many it is known as wild or prairie timothy, because of its external resemblance to the common cultivated timothy.

One of the most common and valuable "bunch-grasses" on the plains is *Poa buckleyana*. It is most abundant on the high elevated plains and-

bench lands nearer the mountains, and is usually accompanied by prairie June-grass, blue grama, and some of the wheat-grasses. It is not as early as prairie June-grass, but affords a larger amount of forage and is much better for winter pasturage. It has a very wide distribution in the Rocky Mountain region and is represented by a great variety of forms, some of which, as already mentioned in another connection, are valuable hay producers.

In poor sandy soil, or in that containing a large percentage of alkali, the rush-grasses (*Sporobolus* spp.) are important pasture grasses. They are all rather harsh and unpalatable and are valuable chiefly because they thrive in soil that will produce none of the better grasses. When forage is plentiful, stock will not eat them to any great extent, and the plants soon become tough and woody, but during seasons of scarcity these grasses are, like others, kept closely grazed throughout the season and are tenderer and more palatable. During the past season a number of extensive pastures were observed in the Big Horn Basin composed almost exclusively of fine-top rush-grass or salt-grass (*Sporobolus airoides*). (See fig. 21.) These pastures were in alkali bottoms and old lake beds, and were almost the only grass-covered areas of any consequence in that locality. They were grazed by horses principally, and were reported to be improving with continual pasturing. This grass is most abundant in the southern portion of the region, though occurring throughout.

FIG. 21.—Fine-top salt-grass (*Sporobolus airoides*).

Among other rush-grasses of general occurrence in this region are rough-leafed salt-grass (*Sporobolus asperifolius*), a characteristic "bad-land" grass; sand rush-grass (*S. cryptandrus*), often abundant in sandy prairies and river bottoms; and prairie rush-grass (*S. depauperatus*). There are two forms of the last occurring in this region; one found chiefly in dry soil of prairies and hillsides, too small to be of much value

for forage, and the other in moist, more or less alkaline bottom land, tall and slender and producing a greater amount of forage.

Another grass abundant throughout this region in strongly alkaline soils, but of little value except in times of scarcity of forage, is the common salt- or alkali-grass (*Distichlis spicata*). (See fig. 22.) Although often producing a great deal of leafage, it is harsh and unpalatable and is refused by stock as long as other grasses are to be obtained. Sheep eat it more readily than other stock. It is abundant in the bad-land regions, and, as better grasses are usually scarce there, it is sometimes cut for hay. In localities where the land is becoming "alkalied" through improper irrigation, this grass is spreading rapidly and often becomes quite a pest.

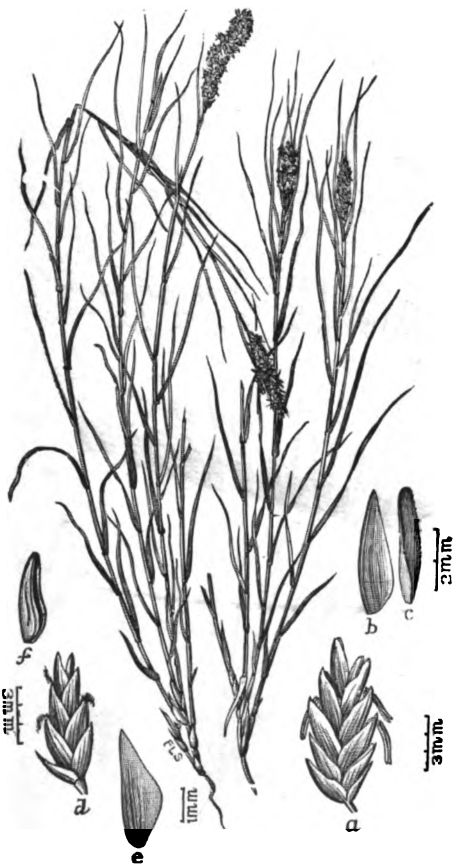

FIG. 22.—Salt-grass (*Distichlis spicata*).

Montana sand-grass (*Calamagrostis montanensis*) is the only representative of this genus that is of much importance as a pasture grass on the dry prairies and foothills. Its distribution is rather local, but where it does occur in any quantity it is a valuable grass. It thrives on sterile, sandy prairies and hillsides and produces a large amount of leaves. It cures well on the ground, and hence affords good winter pasturage. It has not been reported south of the Big Horn Basin, in Wyoming, where it was found the past season in considerable abundance, particularly along the Gray Bull River, on the west side of the basin. It was first observed in quantity at about 5,000 feet altitude, growing on dry, sandy flats and bluffs, continued plentiful up to about 7,000 feet and then gradually became less and less common, disappearing entirely at 8,000 feet.

GRASSES OF THE FOOTHILLS AND MOUNTAINS.

The grasses of the lower foothills differ but little from those of the plains. The sod-forming species become more confined to the valleys and the "bunch" grasses become more and more conspicuous on the bluffs and hillsides. As the higher foothills and mountains are

approached, however, changes in the grass flora become apparent. The gramas and wheat-grasses of the plains are replaced by "bunch-grasses" of various kinds, sheep fescue (*Festuca ovina*), and mountain wheat-grass (*Agropyron violaceum*); brome-grasses become more abundant; the common needle-grass, porcupine-grass and feather bunch-grass give way to Tweedy's needle-grass (*Stipa tweedyi*), Nelson's needle-grass (*S. nelsoni*), and purple-top needle-grass (*S. minor*); wild oat-grasses, meadow or spear-grasses, and tussock-grass become plentiful; and mountain blue joint takes the place of common blue joint and yellow-top.

In the dry soils of the higher foothills and mountains the most important pasture grasses are the "bunch grasses" and the oat-grasses. The former term is a very general one, and as used on the range includes a great many different kinds of grasses. For example, in Colorado "bunch-grass" probably most often means one of the fescues (*Festuca scabrella*), more properly called buffalo bunch-grass; in Wyoming and Montana the term is probably most often applied to the three *Poas* mentioned under the discussion of meadow-grasses, but is also often applied to certain of the fescues, as sheep fescue—often also called "deer grass"—and King's fescue (*Festuca kingii*) (see fig. 23), the northern representative of buffalo bunch-grass. Some of the wheat grasses (*Agropyron divergens* and *A. vaseyi*) are also "bunch-grasses," but as a rule some modification of the term is used in designating them, as wire bunch-grass or bunch wheat-grass. All the above-mentioned grasses are valuable as forage producers and are widely distributed, most of them occurring over all or at least a large portion of the eastern Rocky Mountain region. In the higher altitudes sheep fescue, the bunch-grass *Poas*, and the wild-oat-grasses furnish most of the

FIG. 23.—King's fescue (*Festuca kingii*).

pasturage in the dry parks and open places. The mountain form of prairie June-grass (*Koeleria cristata*) is often sufficiently abundant to form a large part of the pasturage in such places.

In the moister soils the pasturage is furnished by the grasses mentioned in the discussion of mountain meadows, supplemented by various additional species of more local occurrence or of less vigorous growth, and hence of less value as forage producers.

Among such additional species might be mentioned downy oat-grass (*Trisetum subspicatum molle*), American oat-grass (*Avena americana*), and a variety of Californian oat-grass (*Danthonia californica unispicata*). The first is an abundant and widely distributed grass, flourishing in a variety of soils, but most commonly found in rather moist open woodlands and edges of thickets. American oat-grass is rather local in distribution, is seldom found below an altitude of 6,000 feet in Montana and Wyoming or about 7,500 in Colorado, and is most abundant in the upper part of the eastern Rocky Mountain region. It usually occurs in rather dry bottoms or on hillsides, and when plentiful affords much good forage. The variety of Californian oat-grass is smaller than the species and is generally found on dry ridges and hillsides, while the species occurs in rather moist meadows. It is quite abundant in portions of Wyoming and western Montana and is regarded as a good pasture grass, to some extent taking the place, in high altitudes, occupied by blue grama on the plains.

NATIVE CLOVERS, VETCHES, AND LUPINES.

The eastern Rocky Mountain region is well supplied with native leguminous plants, many of which are of great value for hay and pasturage. Some are unpalatable and are seldom eaten by stock, and a few are injurious when eaten in any considerable quantity, due to certain poisons or other active principles contained in them. In the three States included in this report there are more than a dozen native clovers, eight or ten native vetches and vetchlings, at least fifty milk-vetches or rattleweeds, two bush-peas, a dozen or more lupines, and a host of other legumes.

THE CLOVERS.

The native clovers are found chiefly in the mountains and at comparatively high altitudes. Some of them are too rare and others too small to be of much value for forage, but the majority are valuable, and four or five are of sufficient importance to warrant careful experimentation as to their possible use as cultivated crops. From their appearance and thriftiness under natural conditions or in irrigated native meadows it would certainly seem probable that several of them would prove of great value for cultivation, especially in the higher altitudes, where alfalfa and the common clovers can not be successfully grown.

Among the most important of these native clovers are Beckwith's clover (*Trifolium beckwithii*), long-stalked clover (*T. longipes*), moun-

tain red clover (*T. megacephalum*), Parry's clover (*T. parryi*), silky dwarf clover (*T. dasyphyllum*), woolly-headed clover (*T. eriocephalum*), and Hayden's clover (*T. haydeni*). Of these, the first three are probably the most valuable. Beckwith's clover has the lowest altitudinal limit. It is abundant in rich meadows in some localities in southwestern Montana at an altitude of about 5,000 feet, and extends as far to the eastward as the Sioux Valley in South Dakota, where it is frequently abundant, though rather local in distribution. It makes a very fine growth in the rich irrigated meadows in Montana, and is regarded as a valuable hay plant. In South Dakota it is found along rather dry swales and creek bottoms and affords a considerable amount of pasturage, and under more favorable conditions becomes large enough to be cut for hay. It seems to endure drought quite well, better than the common red clover, and is well worthy of experimentation. On account of the similarity of the flower heads to those of the common clover, it is sometimes called "wild red clover."

FIG. 24.—Mountain red clover (*Trifolium megacephalum*).

Long-stalked clover is one of the commonest of the clovers native to this region, and has a wide distribution, extending from southern Colorado along the Rocky Mountains to British America and west to the Pacific Slope. It is seldom found below an altitude corresponding to 6,000 feet in southern Colorado. It is at its best near the uppermost limit for alfalfa, and is often found in quantity up to 9,000 feet altitude. It is a slender, narrow-leafed plant, usually a foot or more in height, with pale, cream-colored or purplish flowers. It is highly prized as a forage plant by stockmen, by whom the pale-flowered variety is sometimes called "wild white clover." It makes a fine growth in irrigated meadows and deserves to be given a trial under cultivation.

Woolly-headed clover has much the appearance of long-stalked clover, and occurs in similar situations, but seems to have a more limited distribution, and is chiefly confined to the region west of the Continental Divide.

Mountain red clover (see fig. 24) is one of the most robust-growing native sorts found in the Rocky Mountain region. The flower heads are large and showy, and the leaves are composed of from five to seven leaflets, instead of three, as is the case with the other clovers of the

region. It produces stout, deep-growing roots, and has many other qualities commending it to the attention of the experimenter. Like the preceding, it is most widely distributed on the west side of the Continental Divide.

The other clovers mentioned in the preceding list are all rather small and are of especial value only as pasturage. The most important are: Parry's clover, generally distributed in the central Rocky Mountain region, and most abundant at an altitude of from 10,000 to 13,000 feet; silky dwarf clover, likewise occurring in the central Rocky Mountain region, but with lower altitudinal limits and growing on drier soil than Parry's clover; and Hayden's clover, occurring in moist soil from Wyoming north along the mountains at an altitude of from 7,000 to 10,200 feet.

All the clovers mentioned in the preceding pages are perennials. There are only two or three species of the annual clovers native to the region. Annual red clover (*Trifolium involucratum*) is widely distributed and is by far the most valuable of the annual sorts. Few-flowered clover (*T. pauciflorum*) is occasionally met with, and it is likely that small-headed clover (*T. microcephalum*) may occur in western Colorado and southwestern Wyoming. The annual clovers are all found at comparatively low altitudes.

THE VETCHES AND VETCHLINGS.

Two species of the true vetches occur in this region and both are of value for forage. American vetch (*Vicia americana*) is found in rich, moist meadows and open thickets, and is regarded as a valuable native forage plant. It produces long trailing or climbing vines quite thickly covered with leaves and affords a good yield of forage. Narrow-leafed vetch (*V. linearis*) is much smaller than the preceding, occurs in drier situations, and, like it, is distributed throughout the entire region. It affords less forage than American vetch, and is less palatable, but thrives on soil too dry for that species, and hence replaces it in many localities. It is a hardy, aggressive plant, and rapidly takes possession of idle, broken land, under some circumstances becoming a weed, although not a troublesome one.

The vetchlings are better represented in this region than the true vetches, some five or six kinds being found, of which at least three are of value for forage. They are not very palatable in the fresh state, and hence are of more importance as hay plants. The most valuable sorts are the prairie vetchlings (*Lathyrus ornatus* and *L. polymorphus*) and marsh vetchling (*L. palustris*). The former are found chiefly in the central and southern portions of the region, while the latter occurs throughout.

Small prairie vetchling (*L. ornatus*) is usually found in dry prairies, and in some parts of the region, as in southeastern Wyoming, is very abundant. It fruits plentifully, and the seeds are said to be edible,

comparing favorably with the common garden pea. The larger prairie vetchling (*L. polymorphus*) occurs in rather moister situations than the preceding and is a somewhat more robust plant with much larger flowers. It is very abundant in portions of central and southern Colorado, where it is regarded as a valuable element in native meadows.

Marsh vetchling is a much taller plant than either of the foregoing and occurs chiefly in rich, moist meadows and about the edges of thickets. It is frequently sufficiently abundant to form an important part of the hay, adding very materially to its feeding value. In some localities it is called "meadow pea."

Among other vetchlings occurring in this region of more or less value as forage plants are veiny-leafed vetchling (*Lathyrus venosus*), growing usually on sparsely wooded hillsides and river banks, and cream-colored vetchling (*L. ochroleucus*), found in similar situations to the preceding.

FIG. 25.—Dakota vetch (*Lotus americanus*).

One of the most valuable leguminous plants found on the prairies is Dakota vetch (*Lotus americanus*) (see fig. 25), a bushy annual growing throughout the entire Rocky Mountain region. It is most abundant on sandy river bottoms, but also occurs on the drier uplands. Stock is very fond of it, either as pasturage or as hay. In the Upper Missouri region it is one of the most highly prized native forage plants, and the rancher who has a good lot of it in his meadows and pastures considers himself fortunate. As it is an annual it must be allowed to mature its seed and should not be grazed too closely nor cut too early. The blooming season is quite long, so that buds, flowers, and both green and mature fruits may often be seen on the plant at the same time. As a rule many of the seeds are ripened before haying time arrives, and it is a common practice among ranchers to use hay racks with tight bottoms in order to save the shattered seed that it may be scattered over thin places in the meadows.

THE LUPINES.

Although the wild lupines are so abundantly represented in this region, as to both kinds and individuals, they can hardly be regarded as of much value for forage from the fact that they are generally so unpalatable that stock will seldom eat them unless forced to do so by

hunger. Sheep eat them more readily than other stock. Many of the species thrive on dry, rocky soils too poor to produce much other vegetation, and they probably do a great deal toward improving the fertility of these soils, and are thus indirectly beneficial; but many ranchers regard them as weeds, owing to their tendency to spread rapidly in overstocked pasture lands.

THE MILK-VETCHES.

The milk-vetches, or rattle-weeds, as some of them are called, are by far the best represented group of leguminous plants in the range region. Of the numerous sorts some are valuable forage plants, others are too small to be of any value or are so unpalatable that stock will not eat them, and a few—the so-called "loco weeds"—are injurious to stock under certain circumstances, causing considerable loss by killing the animals eating them.

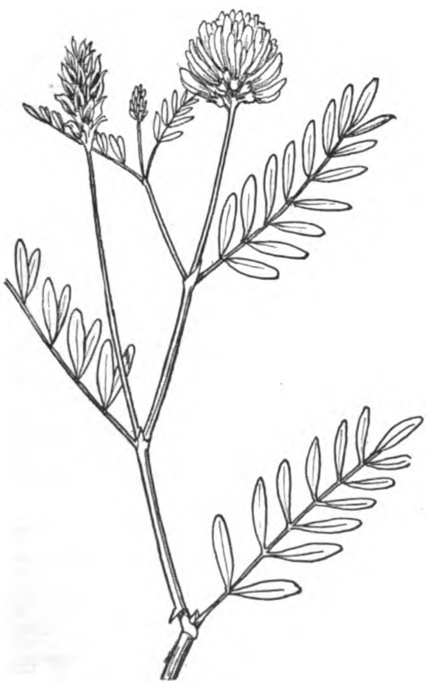

FIG. 26.—Prairie milk-vetch (*Astragalus adsurgens*).

The milk-vetches occur on a great variety of soil, from rich, moist bottom lands to dry, sterile, rocky, and gravelly ridges, often forming a large proportion of the vegetation. In some of the species the fruits are large and fleshy and are much sought after by stock, particularly by sheep. There are probably a great many kinds that are of more or less value as forage plants, but our knowledge of the real value of most of the species is very limited and reports are contradictory, some stockmen regarding certain sorts as injurious, while others maintain that they are valuable forage plants, stock eating them with the best of results.

Among the most common and valuable kinds are bristly-fruited milk-vetch (*Astragalus hypoglottis*), ground plum or buffalo pea (*A. crassicarpus*), larger ground plum (*A. mexicanus*), and prairie milk-vetch (*A. adsurgens*), (see fig. 26.) Other species, regarded by many as valuable, are Morton's milk-vetch (*A. mortoni*), zigzag milk-vetch (*A. flexuosus*), and slender milk-vetch (*A. gracilis*). Low milk-vetch (*A. lotiflorus*) and bitter milk-vetch (*A. bisulcatus*) are by some regarded as good forage plants and by others as injurious species. Some years

ago the writer observed both cattle and horses eating considerable quantities of the former without any apparent ill effect, but the latter is so bitter and strong-scented that it would hardly seem possible that stock would eat much of it.

RUSHES AND SEDGES.

These grass-like plants play no small part in the forage supply and are of much more importance than is generally understood. There are almost as many kinds of rushes and sedges native to this region as there are grasses, and all are eaten by stock to a greater or less extent. Comparatively few kinds grow on the dry prairies and hills, most of them occurring in low prairies, meadows, and bogs. Sometimes the greater part of the hay obtained from wet, boggy meadows is made up of these plants. They are particularly abundant in some of the mountain meadows, frequently, especially early in the season, occupying the land almost to the exclusion of the grasses.

RUSHES.

There are at least six of the bulrushes that deserve mention as forage plants. These are meadow bulrush (*Scirpus atrovirens*), salt-marsh bulrush (*S. robustus*), river bulrush (*S. fluviatilis*), small-fruited bulrush (*S. microcarpus*), prairie bulrush (*S. campestris*), and alkali or chair-makers' bulrush (*S. americanus*). The best of these, though not necessarily the most abundant, are river bulrush, meadow bulrush, and salt-marsh bulrush. Alkali or chair-makers' bulrush (the former name is most used in this region) is one of the most abundant species, and, as its common name indicates, occurs on alkali flats along streams and elsewhere in moist soil containing large quantities of alkali. It is tough and wiry, but is often eaten by stock when better forage is scant.

Of the spike rushes, common spike-rush (*Eleocharis palustris*) and flat-stemmed spike-rush (*E. acuminata*) are the most important. In wet meadows, particularly those that are overirrigated, these rushes are very abundant, sometimes forming the larger part of the vegetation. Some of the larger forms of common spike-rush yield a large amount of hay, but the quality is much inferior to that obtained from the grasses.

There are a dozen or more of the bog rushes found in the eastern Rocky Mountain region. All are tough and wiry and afford an inferior quality of forage, but a number of them are sufficiently abundant to form a large part of the vegetation in some of the native meadows. The species most frequently found are slender bog rush (*Juncus tenuis*), Torrey's bog rush (*J. torreyi*), Baltic bog rush (*J. balticus*), knotted bog rush (*J. nodosus*), Nevada bog rush (*J. nevadensis*), and mountain bog rush (*J. xiphioides montanus*).

SEDGES.

The list of sedges is a long one, more than a hundred different kinds being found in the Rocky Mountain region. They furnish a better quality of forage, as a rule, than that obtained from the rushes. Some of the species grow on dry prairies and hillsides, but the majority prefer the moister soils of the valleys and lowlands. Sedges form a conspicuous part of the vegetation of the meadows and moist mountain sides at the higher altitudes. Some of the species are small and are of value only as pasturage, but many others are of sufficient size to yield a large amount of hay which compares favorably in quality with that obtained from grasses growing in similar situations.

On the dry uplands, thread-leafed sedge (*Carex filifolia*), often also called "wire-grass," and dwarf sedge (*C. stenophylla*) furnish pasturage, the former being very abundant on dry ridges in some localities and highly prized by stockmen. Dwarf sedge is often plentiful in dry meadows, where it is larger than on the uplands. In swales and dry meadows silvery-top sedge (*C. siccata*), clustered field-sedge (*C. marcida*), and Douglas sedge (*C. douglasii*) are of considerable value for both hay and pasturage. There are a great many different forms of the Douglas sedge, some of them large and affording a good yield of hay, and others too small for anything but pasturage. The species is one of the most abundant in the sections nearer the mountains and also ascends to the higher altitudes. Brown-top sedge (*C. festiva*) is also abundant and valuable, but usually occurs in moister situations than the last. In wet, boggy meadows the sedges sometimes compose more of the vegetation than do the grasses. This is particularly the case at the higher altitudes or above 7,000 or 8,000 feet. The species most commonly found in these meadows are tussock sedge (*C. stricta*), bottle sedge (*C. utriculata*, and var. *minor*), Nebraska sedge (*C. nebraskensis*), woolly-fruited sedge (*C. lanuginosa*), and giant sedge (*C. aristata*). All produce a relatively large amount of leafage, and when cut in proper season afford hay of average quality.

MISCELLANEOUS NATIVE FORAGE PLANTS.

There are many miscellaneous plants native to this region that help to make up the general forage supply. These are mostly plants that the uninformed individual would regard as weeds, but which, under the conditions prevailing on the range, form an important part of the annual supply of stock feed. On the plains and foothills this vegetation consists very largely of the various kinds of "sage" and saltworts, plants characteristic of the arid and semiarid West. In the mountains it consists mainly of shrubby willows, mountain mahogany, shrubby cinquefoil, and purshia. There is a great variety of plants called "sage" on the range, as, for example, the bitter sages, or "sage-brush" (*Artemisia* spp.); green sages, or "rabbit-brush" (*Bigelovia* spp.); salt-sage (*Atriplex* spp.); sweet sage, or winterfat (*Eurotia lanata*), etc.

THE BITTER SAGES.

The bitter sages, or sage-brushes, are most of them so bitter that stock will not eat them as a general thing, except in times of scarcity of forage. Sheep eat the sage-brush more often than do any other of the domestic animals. They do not make a general diet of it, but eat small quantities now and then, as if for a tonic or appetizer. Bud brush or spring sage (*Artemisia spinescens*) is probably the most valuable of this group of sages. It is most abundant in the Red Desert of Wyoming, and extends into the arid regions to the southwest. The masses of young leaves and flowers are much relished by sheep, and the plant is regarded as an important member of the forage-producing species of the desert. Silvery sage (*A. cana*) is probably the next most valuable of the bitter sages. When browsed closely it produces a great many annual shoots, which are quite succulent and are eaten by sheep to a considerable extent.

Fig. 27.—Shad scale (*Atriplex canescens*).

THE SALT-SAGES.

The salt-sages are of much more importance as forage plants than the bitter sages. There are more than a dozen species native to this region, and all are of value for forage. In some sections, as in central Wyoming and in the Red Desert, these salt-sages, or "salt-bushes," furnish more of the forage than all the other plants combined. The kinds of most importance in this region are Nuttall's salt-sage (*Atriplex nuttallii*), spiny salt-sage (*A. confertifolia*), hoary salt-sage, or shad scale (*A. canescens*) (see fig. 27), Nelson's salt-sage (*A. pabularis*), silvery salt-sage (*A. argentea*), tumbling salt-sage (*A. volutans*), and spreading salt-sage (*A. expansa*). All are annuals except the first three, which are perennials and are of especial importance for winter pasturage. The leaves, fruits, and young shoots are relished by all kinds of stock. Of the three, Nuttall's salt-sage is probably the most valuable.

The salt-sages thrive on land strongly impregnated with alkali, and so dry that but little other vegetation will exist upon it, and as there are many thousands of acres of such land in this region these plants are of particular importance. In certain districts, as along the Green River in Wyoming and also in the central part of the State, there

are extensive areas in which the water supply is so limited that stock can not be kept on them during the summer. Here it is that the salt-sages thrive, and are of especial value for winter forage. During the growing season the plants make a good development, as they are not kept back by grazing, and the ripened fruits and "sun-cured" leaves, together with the young shoots, make excellent forage for winter, when, since the snow furnishes the animals with water, the stock can be brought to these regions. Thus it is that these desert areas become valuable winter pastures and furnish food for many thousands of sheep, cattle, and horses for about four months of the year. Stockmen, especially those owning large droves of sheep, are almost as anxious to establish and maintain their rights to "winter ranges" on these desert areas as they are to secure their "share" of the summer range on the prairies and in the mountains.

Under this system of winter grazing the condition of these salt-sage pasture lands is continually improving. This is probably due to the enriching of the land from the droppings of the animals, and to the increased production of new shoots by the perennial sages, resulting from the close browsing by the animals during winter, followed by an undisturbed period of growth in the summer.

The annual salt-sages are valuable principally for summer and autumn forage, not usually being persistent enough to be of much importance for winter use. However, under certain circumstances, the fallen leaves and fruits may be collected by the wind into little piles in depressions of the ground, or behind shrubs and other persistent plants, and are picked up by sheep or other stock. Under ordinary conditions all of the salt-sages mentioned in the above list produce an abundance of seed, and in most cases it is easily gathered. In view of the recognized value of these plants for forage it would seem well worth while to attempt to grow the better sorts under cultivation. There are many localities where they could be used to advantage.

WINTERFAT.

One of the most highly prized of the sages is winterfat or sweet sage (*Eurotia lanata*). (See fig. 28.) It is a rather small, woolly, half-shrubby perennial, found throughout the Rocky Mountain region in the dry soil of the plains and foothills. It is of most importance for winter pasturage and is esteemed not only for its feeding value, but also for a beneficial effect which it is supposed to have on the health of stock eating it. It usually fruits abundantly, and the great fattening qualities attributed to it are no doubt largely due to the fact that the matured fruits compose a large part of the forage obtained by the animals.

Winterfat grows readily from the seed and could undoubtedly be cultivated to good advantage in many localities.

GREASEWOOD.

Another plant of great value for forage on dry, sterile, strongly alkaline soil is greasewood (*Sarcobatus vermiculatus*). (See figs. 3 and 29.) It is more or less abundant throughout the entire region and is of especial importance in the bad lands and in sterile, broken areas on bluffs along the streams, and on the so-called "black alkali" spots in the valleys and plains. It is a scraggy, thorny shrub from 2 to 10 feet high, with fleshy, succulent leaves, and usually produces an abundance of fruit. The leaves, fruit, and young shoots are eaten by stock to such an

FIG. 28.—Winterfat (*Eurotia lanata*).

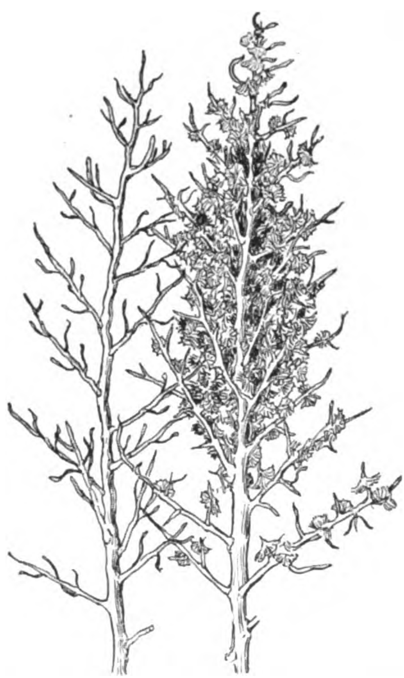

FIG. 29.—Greasewood (*Sarcobatus vermiculatus*).

extent that in some localities the plants are kept so closely browsed as to be ultimately destroyed. Under ordinary conditions this plant furnishes a large amount of forage and is particularly valuable, since it will thrive on soil that will not even produce sage-brush. As stated elsewhere in this report, "sage-brush" land is easily subdued, and under irrigation produces excellent crops of grain, alfalfa, etc., while "greasewood" land is regarded as of but little agricultural value by ranchers because of the quantity and character of the alkali contained in it.

MISCELLANEOUS.

Among other plants of weedy habit which add considerably to the forage supply in some localities are the goosefoots or lambs-quarters

(*Chenopodium* spp.) and the knotweeds (*Polygonum* spp.). There are a half-dozen species of each that occur in sufficient abundance to be of value. They are usually found in broken soil along banks and trails and about desiccated ponds, occupying land in which grasses will not thrive or from which they have been killed out.

In the higher foothills and mountains the browsing is principally furnished by such shrubby plants as the willows, shrubby cinque-foil (*Potentilla fruticosa*), mountain mahogany (*Cercocarpus parvifolius*), Torrey's nine-bark (*Physocarpus torreyi*), and Purshia (*Purshia tridentata*). These are all often so extensively eaten by stock that it is difficult to find a plant showing anything like its natural habit of growth. This is particularly true on the sheep ranges. Shrubby cinque-foil was seen in great abundance the past season (1897) on the Big Horn Mountains, but wherever the sheep had been ranged to any considerable extent the bushes were so closely browsed that it was difficult to get good botanical specimens. The same was true to a great extent with the several species of shrubby willows occurring on the same mountains.

FIG. 30.—Montana bush-pea (*Thermopsis montana*).

Wild liquorice (*Glycyrrhiza lepidota*) is abundant in low, sandy prairies and river bottoms throughout the range region. This plant, regarded as a troublesome weed in the eastern prairie States, is highly esteemed as a forage plant by many ranchers. It is often present in abundance in the hay obtained from river-bottom meadows, and such hay is regarded as having high feeding value. In the Big Horn Basin it is frequently called "wild alfalfa," and many tons of it are cut annually.

In addition to the various plants mentioned in the preceding pages, all of recognized value as forage producers, there is a long list of plants which, although each is perhaps of but little value in itself, when they are considered in the aggregate the amount of forage afforded by them is large. Such are the prairie clovers (*Petalostemon* spp. and *Psoralea* spp.), the Daleas (*Dalea alopecuroides* and *D. aurea*), the bush-peas (*Thermopsis montana* (see fig. 30) and *T. rhomboidea*), the herbaceous cinque-foils (*Potentilla* spp.), wild asters, and many others.

IMPROVEMENT OF THE RANGES.

One of the most important factors in the improvement of the range conditions would be the establishment of some system of control which would allow each rancher the exclusive right to graze his stock on a given piece of land for a long term of years. As long as the "open range" is "free to all," ranchmen will continue to try to get their "share" of it and there will be no possibility of any substantial improvement. Under the present conditions there is no incentive for the rancher to make any special efforts to improve the range except in so far as it has to do with the immediate necessities of his stock. He knows that if his stock does not eat the grass, that of somebody else will, and naturally he thinks he might as well benefit by it as anyone. In his efforts to get his "share" he contributes to the general destruction instead of trying to avert it.

It is argued that if the rancher could secure a long lease to a portion of these public lands it would then be to his interest to improve and maintain their productivity. He could then afford to build fences and adopt other measures for the betterment of his holdings, being sure that he and not someone else would get the benefit of his endeavors.

With the recent rapid increase in the number of tilled ranches and the growing tendency toward the raising of more coarse forage for winter feeding, it ought to be possible to handle more stock than formerly instead of less, as is the case at the present time. Thus in the Big Horn Basin and elsewhere in northern Wyoming ranchers assert that they can easily raise winter feed for more stock than their summer range will carry in its present depleted condition. This statement is borne out by the fact that on many ranches one may see large quantities of surplus hay, often representing portions of crops of two or three years. There are other districts in which the practice of growing forage for winter use should be greatly extended. The range could supply plenty of pasturage for a part of the year, but is insufficient for both summer and winter forage. Millet, rye, oats, field peas, rape, sorghum, and other forage crops can some of them be grown with at least a fair degree of success in most localities in this region, and an extension of their cultivation would have a beneficial effect on the open range, in that it would be less closely grazed.

An important problem to be considered in connection with the improvement of range conditions is that of the water supply, particularly as to the conservation and more equable distribution of the annual rainfall. Something can be done by the individual efforts of the stockmen, but if much permanent good is to be accomplished the united efforts of the community and possibly the aid of the local or the General Government will need to be turned in this direction.

The conservation of water in this manner would serve a twofold purpose. Not only would it render possible the irrigation of more land adapted to the growing of forage and other crops and the better irriga-

tion of land already under cultivation, but water would also be provided for stock in places convenient to the grazing lands, and much of the injury to the range due to excessive trampling would be avoided. As the laws governing the distribution of water for irrigation become better understood and more justly applied much of the present unequal distribution of the water from the running streams will be corrected, and stock will be better supplied with drinking water and more forage will be produced. Under the present conditions one may frequently see a man injuring his meadows and fields by using too much water, while those of his neighbor some miles down the valley are suffering, perhaps totally ruined, for lack of water.

In a region varying so widely in soil and climatic conditions it is not to be expected that any one or two grasses or forage plants can be introduced to meet all the requirements. Timothy, redtop, alfalfa, and other of the commoner "tame" sorts have shown themselves admirably adapted for certain localities. Smooth brome is being used with fine success in some of the drier sections. But other varieties are needed, and the only way to select them is through careful experimentation. It is not neces ary that these experiments should be elaborate. Each rancher should test one or two of the hardy grasses or forage plants in a small way each season, and thus determine for himself what kinds are best adapted to his needs and to the conditions prevailing in his locality.

These experiments should not be confined to "tame" or introduced sorts, but should be extended to desirable native kinds, such as have been mentioned in the preceding pages. There is no locality without native grasses or forage plants that are worthy of trial under cultivation, and anyone can, with but little trouble, obtain enough seed for such a test. Some farmers are already following this plan, and while some attempts meet with failure, others give very encouraging results—so much so that the great value of some of the native species is clearly demonstrated for certain localities, and in some cases the seed is being placed on the market, as for example, slender wheat-grass (*Agropyron tenerum*) and reed canary-grass (*Phalaris arundinacea*). It is extremely likely that there are native varieties of grasses and clovers which will be found to be well adapted for cultivation above the altitudinal limits of timothy, alfalfa, and other of the commonly cultivated grass and forage crops. Among such may be mentioned Nevada blue grass (*Poa nevadensis*), Wyoming blue grass (*P. wheeleri*), rough-leafed bent (*Agrostis asperifolia*), mountain foxtail (*Alopecurus occidentalis*), short-awned brome (*Bromus breviaristatus*), western brome (*B. pumpellianus*), Beckwith's clover (*Trifolium beckwithii*), and long-stalked clover (*T. longipes*).

As a general rule ranchmen assert that the only treatment required for the restoration of the range is rest, but this under the present conditions is practically an impossibility. Moreover, in some localities the

work of destruction has gone so far that something more than mere rest is necessary. The valuable grasses have been killed out and their places taken by plants of weedy habit, of little, if any, value for forage, or the land is without vegetation at all. To reclaim such areas artificial seeding is necessary. With these places again seeded and producing forage it will be easier to give at least a partial rest to the lands on which there still remains enough of the good grasses to accomplish natural reseeding. Many farmers and ranchmen in the Northwest have been able to materially increase the stock-carrying capacity of their pasture lands by scattering over the worn spots the seed of such grasses as western wheat-grass (*Agropyron spicatum*), prairie June-grass (*Koeleria cristata*), Kentucky blue grass, and smooth brome. Sometimes these areas are harrowed or "disked" after seeding, and sometimes not. One practice is to seed while the ground is wet and drive stock over the land to work the seed into the soil.

When wheat-grass is already present in considerable quantity the productiveness may be vastly improved by "disking" up the land. Some farmers even go so far as to plow up the land and then allow the wheat-grass to come in again, which it does in a very short time. This latter method keeps the land in better condition and gets rid of weeds, and is a good practice to follow on the smaller ranches. When seed can be had it would be a good plan to sow a small quantity of prairie June-grass, bench-land spear-grass, smooth brome, or other of the better native or introduced sorts, that the land may be occupied at once. Sometimes such annuals as millet, oats, rye, and sorghum can be used to advantage. The practice of fencing the range in such a manner that one portion of it may be grazed while the other is resting is to be recommended. This allows the grasses opportunity to recuperate and to produce seed occasionally.

If each ranchman and farmer could but keep the land under his own immediate control up to the point of greatest productivity the indirect effect upon the open range through decreased demands upon it would be decidedly beneficial. In the absence of some rational system of control for the open range little can be done in a direct way to bring about better forage conditions upon it, but much can and will be done on private holdings as soon as the ranchers realize, as they are beginning to do, that they can not be continually taking from their meadow and pasture lands without adding something to them by care, occasional reseeding, and cultivation.

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INDEX TO BOTANICAL NAMES.

BULLETIN No. 14. Agros. 34

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF AGROSTOLOGY,
Washington, D. C., June 29, 1898.

SIR: I have the honor to present and recommend for publication as Bulletin No. 14 of this Division manuscript containing brief descriptions of the more important economic grasses of this country or those which have been introduced because possessing some merit. This publication it is believed will afford a ready answer to the usual inquiries respecting a large number of our grasses. Much of the matter here presented is taken from Bulletin No. 3 of this Division, but owing to the fact that that bulletin exceeded 100 pages the edition published was limited to 1,000 copies, and consequently was very quickly exhausted. The matter has here been condensed in order that a larger edition may be published to meet the demands of correspondents.

Respectfully,

F. LAMSON-SCRIBNER,
Agrostologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

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ECONOMIC GRASSES.

DESCRIPTIONS.

No. 1. Agropyron caninum (L.) R. & S. Bearded Wheat-grass.

A fibrous-rooted, rather slender, upright perennial, 2 to 3 feet high, with bearded, nodding heads or spikes resembling slender heads of wheat. This grass is more or less frequent in the northern parts of the United States, ranging from Maine westward to the Dakotas. Bearded Wheat-grass is closely related to the more common and better known Couch-grass (*A. repens*), but differs markedly from that species in having no creeping rootstocks, and in the longer beards or awns to the spikelets. No attempts have been made to introduce this grass into general cultivation, but its habit of growth and other characters indicate that it may possess considerable agricultural value. It is readily propagated by seeds, which may be easily gathered.

No. 2. Agropyron divergens Nees. Wire Bunch-grass.

A slender, usually densely tufted perennial, 1 to 2 feet high or more, with very narrow, spreading leaves, and bearded or beardless spikes. The beards or awns, when present, are widely spreading or divergent. This grass is common in the Rocky Mountain and Pacific Slope regions, extending westward to the coast. On rich lands it often grows to the height of 3 feet, but upon the dry bench lands it rarely exceeds a foot or 18 inches in height. On dry lands the stems become wiry with age, and are avoided by stock; but the grass is considered valuable by the ranchmen for winter grazing. Samples of this grass received from some points in the West, particularly from Washington, indicate that it possesses much agricultural value when grown upon good soil, and as it will thrive in the semiarid regions of the Northwest, its cultivation may prove desirable. Propagated readily by seed, which can be easily gathered.

No. 3. Agropyron pseudorepens Scribn. & Smith. Western Couch-grass.

A perennial, with creeping rootstocks, abundant in the northern prairie States, producing tall and leafy stems, which resemble those of Couch-grass, but are less wiry. This is less plentiful in the semiarid belt than the Western Wheat-grass or Colorado Blue-stem, but is better adapted for cultivation as a hay grass because of its softer stems and leaves. It is one of the most promising native species.

No. 4. Agropyron repens (L.) Beauv. Couch-grass. (Fig. 1.)

A grass abundant everywhere in the Eastern and Middle States, growing in the open fields, and in many places it has become one of the worst of weeds. Often the chief labor in managing hoed crops consists in subduing this pest. When once established, it is hardly less difficult to eradicate than the well-known Johnson-grass of the Southern States. It is, however, a valuable hay grass, and for two or three years the yield is large, but, like the Western Blue-stem, it "binds itself out," and the sod requires breaking in order to restore the yield. It is an

excellent grass for binding railroad and other embankments subject to wash, and can be recommended for this purpose. The roots are well known in medicine under the name of *Radix graminis*. The simple infusion is used as a diuretic. Propagated by "root cuttings" or by seed.

FIG. 1—Couch-grass (*Agropyron repens*).

No. 5. Agropyron spicatum (Pursh) Scribn. & Smith. Western Wheat-grass.

A grass closely resembling the Couch-grass of the Eastern States, and by some regarded as only a variety of it. It has the same strong and extensively creeping rootstocks, and the foliage and spikes are very similar, but the whole plant usually has a bluish color, whence the common name "Blue-stem," most frequently applied to it in the West. It grows naturally on the dry bench lands and river bottoms; and, although the yield per acre is not large, the quality of the hay is unsurpassed by any other species of the region where it grows. In Montana and the neighboring States it furnishes a considerable amount of native hay, and is there regarded as one of the most important of the native forage plants. After three or four successive annual cuttings, the yield diminishes very much, but the grass is "brought up" by letting it stand a year or two, or by dragging over the sod a sharp-toothed harrow, thus breaking the roots into small pieces, every fragment of which makes a new plant. This grass is quite distinct from the "Blue-stem" grasses of Nebraska, which are species of *Andropogon* (*A. provincialis*). There are a number of other species of *Agropyron* or wheat-grasses in the Rocky Mountains, some of which are evidently excellent hay grasses and well deserve the attention of the agriculturist.

FIG. 2.—Redtop (*Agrostis alba*).

No. 6. Agropyron tenerum Vasey. Slender Wheat-grass.

A perennial bunch grass growing in the northern prairie region from Nebraska to Montana and Manitoba. Seed of this grass is now on the market, its sterling qualities for hay having long been recognized by Northwestern farmers. It produces an abundance of soft, leafy stems and root leaves, and ripens a large amount of seed that is easily gathered—two of the chief requisites of a good hay grass. This grass is well adapted for cultivation, and the area devoted to it is deservedly increasing each year.

No. 7. Agrostis alba Linn. Redtop or Herd's-grass.

Under the botanical name of *Agrostis alba* are included a number of varieties, some of which have received distinct Latin names; as, for example, *Agrostis vulgaris*

and *Agrostis stolonifera*, and many English or local names; that most generally applied in the Middle and Eastern States being Herd's-grass, and in the South and West, Redtop. The great variability of this grass has led to much diversity of opinion in regard to its value. The taller forms are largely cultivated for hay, being usually mixed with timothy and clover. This grass requires considerable moisture in the soil, and is one of the best for permanent pastures in the New England and Middle States. It makes a very resistant and leafy turf, which well withstands the trampling of stock. It grows well, also, as far south as Tennessee. Among the forms of low growth are two varieties which are unsurpassed, either in fineness or richness of color, for making lawns.

No. 8. Agrostis asperifolia Trin. Rough-leafed Bent.

This grass is common in the Rocky Mountain regions and on the Pacific Slope, growing chiefly in the mountain parks and along water courses. Its slender leafy culms are 2 to 3 feet high, and the narrow, pale-green, and densely flowered panicles 4 to 6 inches long. Judging from the appearance of this grass, it is likely to prove, under cultivation, superior to the Herd's-grass or Redtop of the East, at least for hay.

No. 9. Agrostis canina Linn. Rhode Island Bent.

This species of bent has been introduced into this country from Europe, and is cultivated to some extent in the Eastern States. It resembles Herd's-grass (Redtop) somewhat, but has shorter and narrower leaves. It makes a close sod, and is considered valuable for permanent meadows and pastures. It is one of the best grasses for lawns, and for this purpose should be sown at the rate of 3 to 4 bushels per acre. Retail price of seed quoted in New York catalogues, $2.75 per bushel.

No. 10. Agrostis coarctata (Reichb.) Ehrh. Sea-coast Bent.

A creeping perennial with slender culms, the upright branches 1 foot high, short and narrow flat leaves, and densely flowered panicles 2 to 4 inches long. It grows in damp soils and sands along the sea coast from Newfoundland to New Jersey, often occurring where constantly drenched by the flying salt spray. It is a fine-leafed, excellent turf-forming species, valuable for lawns. A similar if not identical species is common in western Oregon and Washington.

No. 11. Agrostis exarata Trin. Northern Redtop.

The grass upon which this species was founded is a native of Alaska, but a number of forms which occur in the Rocky Mountain regions and on the Pacific Slope have been referred to it. Some of these have been characterized as distinct species, and there are several among them which, from their tall, leafy habit and vigorous growth, indicate the possession of considerable agricultural value, although none of them have as yet been introduced into cultivation. They are deserving of the attention of the agriculturist, and their culture is recommended, particularly on the Pacific Slope. They would doubtless thrive in the Eastern and Middle States, and possibly supplant, by their greater luxuriance and better qualities, some of the species now cultivated.

No. 12. Agrostis scabra Willd. Rough Bent.

A slender, erect, tufted annual, with numerous very narrow basal leaves, and delicate, widely spreading capillary panicles, which at maturity break away from the culm, and are blown about by the wind, hence one of the common names, "fly-away-grass." Before the panicle has fully expanded, this grass is sometimes gathered and sold under the name of "silk-grass" for dry bouquets. It is widely distributed throughout the United States, but is of little or no agricultural value. In irrigated meadows of the Northwest this species, or a form of it, is occasionally sufficiently abundant to furnish a large amount of hay which is regarded of good quality.

No. 13. Agrostis stolonifera Linn. Creeping Bent.

By some regarded as only a variety of *Agrostis alba*, with long, prostrate or creeping stems, well adapted for sandy pastures near the coast, and useful, perhaps, for binding shifting sands or river banks subject to wash or overflow. It makes a good pasture grass for low lands, especially for those which are somewhat sandy, and produces a fine and enduring turf for lawns, for which is is especially well adapted. It is not a productive hay grass, although it has a record of yielding on rich, peaty soil 7,742 pounds of hay and 2,722 pounds of green aftermath per acre. If sown alone, sow at the rate of 2 bushels per acre, or for lawns 3 bushels. Current retail price in New York, $3.50 per bushel.

No. 14. Agrostis vulgaris With. Herd's-grass; Redtop.

This is little more than a variety of *Agrostis alba*, already noted. It is quoted in the seed catalogues as a distinct species, and is recommended for mixtures designed for permanent pastures or meadows. It succeeds as far south as Tennessee, and is often sown with timothy and red clover. Retail price of seed, New York market, $1 to $1.50 per bushel.

FIG. 3.—Water Foxtail (*Alopecurus geniculatus*).

No. 15. Alopecurus geniculatus Linn. Water Foxtail. (Fig. 3.)

A low, usually procumbent grass, with slender stems 8 to 18 inches long, often rooting at the lower joints. It usually grows in wet places, and is very widely distributed throughout the north temperate zone. It has cylindrical heads or panicles, resembling those of Meadow Foxtail, but much smaller. This grass enters into the natural herbage of low, wet meadows and pastures, and in such places affords excellent grazing, being tender and nutritious. *Alopecurus fulvus* is simply a variety of this, with short-awned flowering glumes. Under favorable circumstances this grass makes a good turf and a pleasing lawn of a deep rich green color, remaining green throughout the severe winter weather of the Middle States.

No. 16. Alopecurus occidentalis Scribn. Mountain Foxtail.

A grass of the mountain meadows of the Rocky Mountains, growing in rich soil along streams and in the open parks. It has slender, erect stems 2 to 3 feet high, with short, oblong heads, thicker and shorter than those of common Meadow Foxtail. This grass is occasionally found covering extensive areas to the exclusion of other species. It yields a large bulk of fine, long, bright-colored hay, which is highly valued where it can be obtained. For the more elevated meadows of the Rocky Mountain region, and doubtless also for the New England and North Middle States, this grass would form an excellent addition to the cultivated species, and its introduction is recommended.

No. 17. Alopecurus pratensis Linn. Meadow Foxtail. (Fig. 4.)

This well-known European grass has been introduced into this country and cultivated to some extent in the New England and Middle States. It is a valuable grass for moist meadows and pastures, particularly the latter, on account of its

FIG. 1.—PLANTING BEACH GRASS IN SAND NEAR PROVINCETOWN, MASS.

FIG. 2.—KAFIR CORN IN GRASS GARDEN OF THE U. S. DEPARTMENT OF AGRICULTURE.

early growth, being one of the earliest of the cultivated grasses. It is very hardy, and on good soil yields a large amount of excellent forage. In Europe it is regarded as one of the best perennial pasture grasses. It should enter into all mixtures for permanent pastures, because it is very lasting, highly nutritious, and earlier than most other species. This grass has a record of producing 20,418 pounds per acre of green grass, 6,125 pounds of hay, and 8,167 pounds of aftermath. It is never sown by itself, but is always mixed with other grasses and forage plants, because it gives a full yield only in the second or third year. Average number of seeds in a pound, 907,000. Price of seed quoted in New York catalogues, $2.30 per bushel, or $32 per 100 pounds.

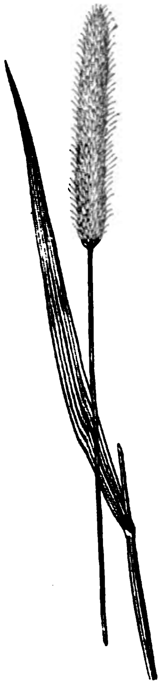


FIG. 4.—Meadow Foxtail (*Alopecurus pratensis*).

No. 18. Ammophila arenaria (Linn.) Link. **Beach-grass.** (Fig. 5.)

This grass grows more or less abundantly along the sandy coasts of the Atlantic and the shores of the Great Lakes. It has strong, creeping rootstocks, upright stems 2 to 4 feet high, and long, rather rigid leaves. The narrow, densely flowered panicles which terminate the stems are from 3 to 10 inches long. It is one of the most valuable grasses adapted to binding the drifting sands of our coasts, and has been cultivated for this purpose in this as well as in other countries. The action of this grass in holding the drifting sands is like that of brush or bushes cut and laid upon the ground in accumulating snow when drifted by the wind. The sand collects around the clumps of grass, and as it accumulates, the grass grows up and overtops it, and will so continue to grow, no matter how high the sand hill may rise. This process goes on over the whole surface of the plantation, and thus many acres may be raised far above their original level. A plant will, by gradual growth upwards, finally form stems and roots sanded in to the depth of fully 100 feet. Beach-grass is best propagated by transplanting (Pl. I, fig. 1). The grass is pulled by hand and planted 1 to 2 feet apart, according to the slope, by forcing a long spade or shovel into the sand, which is then carried forward, making an opening into which the roots are thrust, the spade then being withdrawn and the sand pressed close about them. The planting may be done either in the spring or fall, preferably in the fall. When propagation is by seed, the sowing should be done early in the spring and brush laid over the ground for holding the sand and seed temporarily in place. Beach-grass has been used for the manufacture of coarse paper, and it makes an excellent and very durable thatch. It is of no value for fodder.

FIG. 5.—Beach-grass (*Ammophila arenaria*): *a*, base of culm; *b*, inflorescence; *c*, ligule.

No. 19. Andropogon contortus Linn. Twisted Beard-grass.

A stout, leafy perennial, 1 to 3 feet high, affording excellent grazing when young, but the mature seeds are much dreaded by sheep owners, as by their peculiar structure they not only become attached to and injure the wool, but often penetrate the skin and even the intestines of those animals. The strong rhizomes and tough fibrous roots which this grass has, commend it as a soil binder for river banks, dams, etc. The awns indicate by their twisting the amount of moisture in the air, and may be used as rain or fair weather indicators. In India this grass is used for thatching. It is a native of tropical and subtropical regions of both hemispheres, extending northward into western Texas, New Mexico, and Arizona.

No. 20. Andropogon glomeratus (Walt.) B. S. P. Brook-grass.

A stout perennial, 2 to 4 feet high, with dense, more or less elon-

FIG. 6.—Johnson-grass (*Andropogon halepensis*).

FIG. 7.—Bushy Blue-stem (*Andropogon nutans*): *a* to *f*, details of the spikelet.

gated, broom-like panicles. It grows in low grounds and marshes from southern New York to Florida, also occurring in Mexico and Lower California. This species is esteemed a valuable pasture grass in the South. Its stems and leaves when young, are tender and juicy and are relished by stock of all kinds. Later the stems become tough and woody and are of less value.

No. 21. Andropogon halepensis (L.) Brot. Johnson-grass. (Fig. 6.)

A stout perennial, with smooth, erect culms, 3 to 6 feet high, and strong, creeping rootstocks. The panicles are expanded during flowering and are from 6 to 12 inches long. It is a native of southern Europe and the warmer parts of Asia and northern Africa. It was introduced into this country about sixty years ago, and has now become widely distributed and well known throughout the Southern

States. In the warmer parts of the Southern States it makes rapid growth, is but little affected by drought, and the hay, if cut just as the grass is coming into bloom, is much liked by all kinds of stock. Two or three cuttings may be made during the season. The extensively creeping rootstocks are fleshy and tender, and hogs are very fond of them. These roots literally fill the ground near the surface, and every joint is capable of developing a new stem. This grass, when once it has become established, is exceedingly difficult to eradicate, and hence has come to be greatly feared by the majority of farmers. Unless one wishes to give up his land entirely to Johnson-grass, and can certainly prevent its spreading to the lands of others, its introduction would be of doubtful economy, owing to its powerful and rapidly spreading roots. In India the natives make rude writing pens from the stems.

No. 22. Andropogon hallii Hack. Turkey-foot.

This is a stout grass, from 3 to 6 feet high, closely related to the Big Blue-stem (*Andropogon provincialis*), but appears to be confined to the sandy regions of the West. It is a good sand binder and is common in the sand hills of Nebraska, and extends southward into Texas. Its agricultural value is not known, but although more woody, it is probably nearly as valuable as Big Blue-stem.

No. 23. Andropogon nutans Linn. Bushy Blue-stem. (Fig. 7.)

This is a stout perennial, 4 to 6 feet high, growing in dry soil along the borders of fields and open woods, and on the prairies of the West it often forms a large proportion of the so-called prairie hay. It is held in little esteem in the Eastern and Southern States, but in the West it is said to make excellent hay, and is particularly valuable because of the relatively large amount of long root-leaves which it produces. All stock eat it greedily. In South Dakota it is given the first place among the native grasses as a hay-producing species, thriving best on the rich prairie bottoms. During the dry season it produces but little seed, though it usually makes a good growth of root leaves. In the middle Atlantic States this grass seeds freely and the seeds are easily collected.

FIG. 8.—Big Blue-stem (*Andropogon provincialis*): *a* to *g*, details of the spikelet.

No. 24. Andropogon provincialis Lam. Big Blue-stem. (Fig. 8.)

A stout perennial, with erect, more or less branching, and often bluish or glaucous stems, 2 to 6 feet high, long leaves, and flowers in short spikes, which stand two to five close together at the apex of the stem or its branches. These spikes are bluish or purple, sometimes pale green, and more or less hairy. This grass has

a wide range, extending over the United States east of the Rocky Mountains, and in the West and Northwest, particularly in the Missouri region, it is very abundant, and is highly valued for hay. It grows in a great variety of soils, and under extremely varying conditions of climate, and enters largely into the composition of the hay of the prairies. The early growth consists of a great adundance of long leaves, and if cut in early bloom the hay is readily eaten by horses and cattle, but if allowed to fully mature the stems become hard and woody and the hay produced is of inferior quality. Investigations of the seed production of this *Andropogon* indicate that it matures seed rarely. It is stated that a very favorable season of moisture is required to make it fruit abundantly. This lack of fertility, if really true, will be a serious obstacle to the general propagation of the grass by the usual and convenient method of seeding.

No. 25. Andropogon saccharoides Swz. Feather Sedge-grass.

A variable grass, growing to the height of 1 to 3 feet, with narrow, silvery-bearded panicles. Some forms of this species have been introduced into cultivation for ornament. It is a native of our Southwestern States and Territories, in some of its varieties extending southward to Chile, where it is regarded as one of the best pasture grasses of the Cordilleras.

FIG. 9.—Little Blue-stem (*Andropogon scoparius*).

No. 26. Andropogon scoparius Michx. Little Blue-stem. (Fig. 9.)

A rather slender perennial, 1 to 3 feet high, more or less branched above; the slender racemes are single and terminate the culm or its branches. This grass has a similar range to the Big Blue-stem, extending over nearly all of the United States east of the Rocky Mountains, and in the prairie regions it is nearly always found associated more or less abundantly with the Big Blue-stem and Bushy Blue stem. It is common in the mountain districts of the South, and is valued there for grazing. In the West it is cut for hay, but is not so much thought of as the Big Blue-stem. In South Dakota this is one of the most common grasses in the basins of the Bad Lands.

No. 27. Andropogon sorghum sativus Hack. Includes the cultivated varieties of sorghum.

Andropogon sorghum includes many varieties, a number of which have been recognized by some authors as distinct botanical species under the genus *Sorghum;* others, including Hackel, have referred them all to the genus *Andropogon*. Hackel has elaborately worked out the botanical characters of the species and characterized the known varieties, giving to each a technical name. It is not necessary here to follow out his classification, which is apparently good. In the works of others there is much confusion in the botanical classification, and still more in the application of the common or English names. The same name has been applied to different varieties and the same variety has often been designated under various names. All the forms are of Eastern origin, and have arisen probably from a common stock through ages of cultivation. From varieties of this species are obtained grain, which furnishes nutritious food for man and domestic animals, particularly poultry. Sirup and sugar in commercial quantities are obtained from the saccharine varieties. The variety *saccharatus*, or Chinese sugar-grass, yields about 13 per cent of sugar. Brooms and brushes, used in all civilized countries, are made from the inflorescence of the variety known as broom corn, and all furnish fodder of more or less value for farm stock. In Africa alcoholic

drinks are prepared from the grains, and useful coloring pigments are contained in the fruiting glumes. The variety known as Kafir corn (Pl. I, fig. 2), which grows to the height of 4 or 6 feet, has been cultivated with great success as a fodder plant in the semiarid regions of the West. In fact, all the sorghums will grow in drier climates or under more trying conditions of drought than Indian corn. They may be cultivated in much the same way as that cereal, but the seed may be planted more thickly. In chicken corn or white Egyptian corn (var. *cernuum*) the densely flowered panicle is abruptly bent or recurved, so that it points downward. This variety is largely cultivated in tropical and northern Africa and in some parts of southern Asia, where it is used as a cereal. It is occasionally grown in this country, the seed being prized as food for poultry. The varieties adapted for the production of fodder or silage are particularly valuable for cultivation in the South and Southwest. The amount of fodder produced is often very large, of excellent quality, and there are few among the larger grasses better adapted for soiling. Yellow Milo Maize, White Milo Maize, and Jerusalem Corn, nonsaccharine varieties of *Andropogon sorghum*, are grown both for fodder and for the seed, particularly in the Southwestern States.

No. 28. Andropogon squarrosus. Linn. fil. Vetivert.

A stout perennial, 4 to 6 feet high, with strong, fibrous, and highly fragrant roots. A native of India, occurring also in some of the West India Islands and Brazil, growing in marshes and on river banks. Introduced into Louisiana many years ago, and now spontaneous in some of the lower parts of that State. Cultivated successfully at Knoxville, Tenn., where the fragrance of the rhizomes and roots was developed to a marked degree, but the plants did not bloom. In India this grass is largely used for thatching, and is woven into mats, which serve as screens or shades for doors and windows (tatties), awnings, covers for palanquins, and fans, and brushes used by weavers in arranging the thread of the web are made from either the roots or the whole plant. The roots, laid among clothing, impart a pleasing fragrance to the garments and are said to keep them free from insects. Fans made from the root fibers were among the articles on sale at the World's Fair in the Javanese bazaar. The roots are an article of commerce sold by druggists. In European drug stores the roots are known as *Radix anatheri* or *Radix vetiveriæ*, a stimulant or antiseptic. They yield a perfume known as *vetivert*, or, in India, *itar*.

Fig. 10. — Broom Sedge (*Andropogon virginicus*).

No. 29. Andropogon virginicus Linn. Broom-sedge. (Fig. 10.)

A rigidly erect perennial, 2 to 4 feet high, bearing a narrow, elongated, and loosely-branched panicle of silky-bearded racemes. The stems are strongly flattened near the base, and at maturity they are too hard and woody to be eaten by stock or to be of any value for hay. When young, however, this grass affords most excellent grazing. Milch cows fed upon it are said to yield butter of superior quality. There is probably no native grass better known to the farmers of the South than this, and although possessing some value, as here indicated, it is, broadly speaking, one of the worst weeds of that section, interfering seriously with the formation of permanent meadows. Constant tillage or very close grazing appears to be the only means of keeping this grass from occupying the land.

No. 30. Anthoxanthum odoratum Linn. Sweet Vernal-grass. (Fig. 11.)

A perennial, early-flowering, sweet-scented grass, introduced into this country from Europe, and now widely distributed over the Eastern and Central States. It is an inferior fodder grass, but owing to its earliness it possesses some value in mixtures for pastures, and its sweet scent adds a pleasing fragrance to hay, of which it should form only a small percentage. The leaves have a bitter taste, and the grass is apparently unpalatable to stock, for they will not readily eat it. It is regarded as a serious pest in New Zealand. The stems have been used in the manufacture of imitation Leghorn hats. Average number of grains in 1 pound of pure seed, 924,000. Price of seed quoted in New York catalogues, $6 per bushel. Weight per bushel, about 10 pounds.

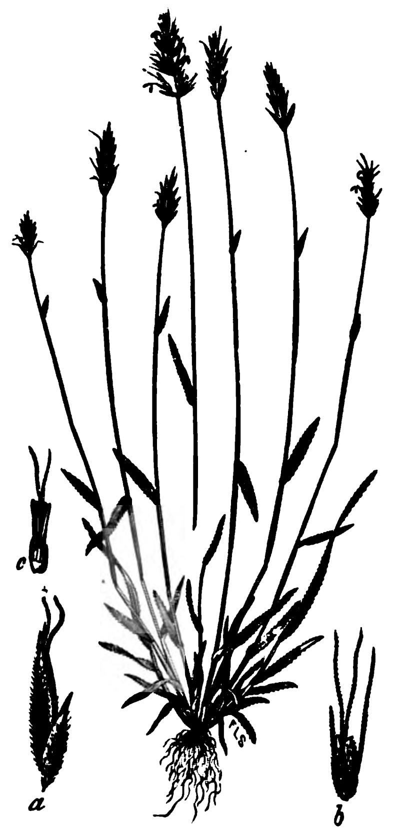


FIG. 11.—Sweet Vernal-grass (*Anthoxanthum odoratum*): *a*, spikelet; *b*, floret; *c*, androgynecium.

No. 31. Aristida fasciculata Torr. Needle-grass. (Fig. 12.)

Needle-grass grows from 6 inches to a foot high, and is a native of the arid regions, from Montana southward to Texas, where it is particularly abundant in poor soils, and presents a great variety of forms. It is usually found in dry, gravelly soils on the plains, mesas, and foothills. In the Eastern and Middle States the species of *Aristida* are deemed of little or no value, but in the Southwest, where every mouthful of fodder of any sort has value, they are not wholly worthless. *Aristida schiedeana* and *A. bromoides*, growing upon rocky and desert soil in Arizona and New Mexico, supply in their thin, scattered tufts "dainty bits seized upon by stock with avidity." (Pringle.)

No. 32. Aristida stricta Michx. Wire-grass.

This is one of the "wire-grasses" of the Southern States, growing to the height of 2 or 3 feet. The simple stems are terminated by a narrow panicle, usually a foot in length. It is common along dry, sandy ridges and in the pine barrens.

No. 33. Arrhenatherum elatius (L.) M. & K. Tall Oat-grass. (Fig. 13.)

A loosely tufted perennial, 2 to 4 feet high, introduced from Europe as a fodder grass and now quite generally distributed over the regions east of the Mississippi. In Europe it is regarded as one of the best meadow grasses, but is not recommended for pastures. It does well in the Southern States, where it is frequently cultivated, and is valued both for winter grazing and for hay. In California it is spoken of in the highest terms, particularly for its drought-resisting qualities. It does not form a very compact turf, and when sown should be mixed with other grasses. It grows rapidly, blooms early, and when cut dries out readily. It is not suited to heavy, moist soils, but thrives best on loamy sands or loams. It produces a large yield, and on good soils three or four cuttings may be

obtained during the season. It is best sown in the spring, but in the Southern States it may be sown in September to advantage. In New Zealand this grass is spoken of as fast becoming a weed in mixed pastures; and, further, it is stated that the early growth is much relished by stock, but later in the season it is not touched. On rich, clayey loam this grass has made a yield of 17,015 pounds of green fodder, 6,380 pounds of hay, and 13,612 pounds of green aftermath per acre. When sown alone, the amount of seed to sow per acre is 5 to 6 bushels. Owing to the structure of the seed, it may be sown deeper than most other grasses. Average number of grains in one pound of pure seed, 159,000. Price of seed, quoted from New York catalogues, $3.25 per bushel, or $18 per 100 pounds.

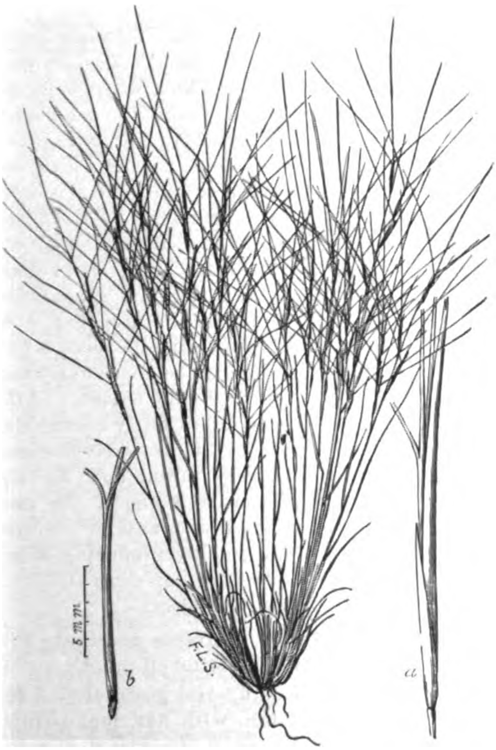


FIG. 12.—Needle-grass (*Aristida fasciculata*): *a*, spikelet; *b*, indurated flowering glume, the awns cut off.

FIG. 13.—Tall Oat-grass (*Arrhenatherum elatius*).

No. 34. Arundinaria macrosperma Michx. Cane. (Fig. 14.)

This is the bamboo which forms the well-known canebrakes of the South. It is perennial, with woody stems 10 to 30 feet high, and evergreen leaves, which furnish a valuable supplement to the winter pastures. The plant blooms but once, and when the seeds mature the cane dies. The canes are used for many purposes, such as fishing rods, scaffolds for drying cotton, splints for baskets, mats, etc. Attempts made to cultivate this grass have not been successful.

No. 35. Arundinaria tecta (Walt.) Muhl. Small Cane.

This is regarded by some as only a variety of the cane mentioned above, but it is of smaller growth, rarely exceeding 10 feet in height, and extends as far north as Maryland. It forms extensive "canebrakes" in many parts of the Southern States, and its perennial leafage, together with the younger stems and branches, supply forage for thousands of cattle during the winter season. This fodder,

however, does little more than sustain the life of the animals. It is of little or no value for fattening cattle or for milch cows.

No. 36. Arundo donax Linn. Reed.

A tall, leafy perennial, attaining the height of 10 to 15 feet, or in very favorable locations even 30 feet. The leaves are broad and widely spreading and the stems are leafy to near the top. The panicle has some resemblance to that of pampas grass, but is not so large. This grass is grown for lawn decoration and to conceal unsightly objects. It is a native of southern Europe, northern Africa, and western Asia, and is said to be spontaneous along the Rio Grande. In some countries the stout stems are used for laths and, when split, for woven work; the leaves are used for thatch or roofing, and the stout rhizomes are employed as a diuretic. A cultivated variety has its broad leaves striped with longitudinal white bands. It presents a very striking appearance. This grass is propagated by transplanting the roots, which work may be done at any time during the season. After growth has fairly commenced the subsequent development is very rapid, and for this reason it is one of the most important plants of its class for quickly producing scenic effects or for concealing unsightly objects.

FIG. 14.—Cane (*Arundinaria macrosperma*): *a*, floret; *b*, palea and lodicules; *c*, grain.

No. 37. Astrebla pectinata F. v. Muell. Mitchell-grass.

A smooth, erect grass, 1½ to 3 feet high, with flat, long-pointed leaves and densely flowered terminal spikes or heads. It is a native of Australia, growing naturally upon the interior plains. It is regarded by the stockmen of that country as the best of all native grasses, both for its drought-enduring qualities and for its fattening properties. If cut just when coming into bloom, it makes excellent hay. The seed is produced in abundance, and is easily collected. This may prove a valuable grass for the semiarid districts of the Southwest. The seeds of this grass, as well as those of the closely related *Astrebla triticoides*, were formerly used as food by the natives of Australia.

No. 38. Avena americana Scribn. American Oat-grass.

In the grassy parks and on the foothills of the eastern slopes of the Rocky Mountains, this *Avena*, which closely resembles the *Avena pratensis* of Europe, is frequently found associated with the other native grasses. Where abundant it

makes a valuable addition to the grazing resources of the country. It is deserving of a trial under cultivation.

No. 39. Avena fatua Linn. Wild-oats. (Fig. 15.)

An erect annual, 2 to 3 feet high, with loose, open panicles, 8 to 10 inches long, the whole aspect of the plant closely resembling forms of the cultivated oat. The spikelets are larger, however, and the flowering glumes are covered with long, brown hairs, and have a twisted awn an inch in length. It is a native of the Mediterranean region, but is now widely distributed over grain-growing countries, and with the closely related *A. barbata* Brot. is especially common in California and Oregon, and has spread eastward to Minnesota. It is of rare occurrence in the Eastern States. By some this is supposed to be the original of the cultivated oat (*Avena sativa*), which is said to readily degenerate into it. *Avena fatua* is in most places regarded as a troublesome weed. When abundant in the grain fields, it occupies the place of better plants, and reduces the grade of the thrashed grain by the admixture of its inferior and lighter seeds. The stiff and twisted awns are injurious to stock, as they frequently cause irritation of the nostrils and mouths of the cattle feeding upon them. In California the young plants, before the bearded or awned spikelets mature, are esteemed for grazing and forage. "The use of the Wild-oat, with its brown, hairy seed and twisted awn, as an artificial fly by fishermen, is well known, the uncoiling of the awn when wetted causing those contortions by which it imitates a fly in trouble." (Hooker.) A form of the Wild-oat with the flowering glume smooth (var. *glabrescens* Coss.) is quite widely distributed on the Pacific Slope, where it has become a most troublesome weed in wheat fields.

Fig. 15.—Wild Oats (*Avena fatua*).

No. 40. Avena pubescens Linn. Downy Oat-grass.

This grass is similar in habit and appearance to *Avena fatua*, but is much less common. It is a European grass, and has thence been introduced into this country. It is occasionally found in the grain region of the Pacific Slope. The soils best suited to the growth of this grass are sandy loams, upon which it is valuable for early mowing and pasturage Under favorable conditions it has produced 15,654 pounds of green fodder, or 5,870 pounds of hay, and 6,860 pounds of aftermath per acre.

No. 41. Avena sativa Linn. Oats.

A well-known erect annual, 2 to 4 feet high, with flat leaves and expanded panicles of rather large pendulous spikelets. There are many varieties, which have been divided into two classes, "panicle oats" with widely spreading panicle branches; and "banner oats" with the panicles somewhat contracted and one-sided. These two races are divided into "chaffy" and "naked-fruited" sorts; further varieties are established upon the color, form, or some special character of the grain. Oats have been cultivated from very early times in Europe, and they

form the principal grain of such northern countries as Norway and Sweden, and Scotland, and in these countries boiled oatmeal and oatmeal cakes are important articles of food. Boiled oatmeal is also much used in this country, especially at breakfast. The grain, however, is principally cultivated here as food for horses. In the Southern States, oats, particularly winter oats, are largely grown for forage. Sown in August, they furnish the best grazing from October to the latter part of April, and will then yield a more certain and a larger crop of grain than spring-sown oats. They are often cut green for soiling and for hay. Oat hay is quite extensively used in the South and in California. The practice is to cut when the grain is in the "dough" stage, or when the straw commences to turn yellow below the head and the leaves are still green. The yield ranges from 3 to 4½ tons per acre, according to the variety and the season. The feeding value of oat hay is higher than that of timothy, containing about 8.8 per cent of crude protein, and 55 to 65 per cent of fat formers, while the latter (timothy) contains from 5 to 7 per cent crude protein, and 45 to 55 per cent fat formers. Among the cereals, oats are the most nutritious, but oaten flour lacks the gluten of wheat, rendering the making of bread from it impossible. Oatmeal is richer in nitrogenous matter than soft wheats, and contains more fat than any of the other grains. Russian "quas" beer is made from oats.

No. 42. Avena sterilis L. Animated Oats.

A stout, oat-like grass, with one-sided panicles, and very large, awned spikelets; the awn is very long, twisted, and "kneed" or geniculate. It is the twisting and untwisting of these awns when exposed to changes of moisture and dryness that has given to this grass the common name of "animated oats." The untwisting or coiling-up of the awn causes the spikelets to tumble about in various directions, suggestive of independent motion or life-like activity.

No. 43. Bambusa. Bamboo.

The bamboos belong to the *Bambuseæ*, a tribe of grasses numbering about 175 species, chiefly limited to South America, southern and eastern Asia, and the East Indies. There are no European species, and only two in North America (see *Arundinaria*). Of the whole number of species only one is common to both hemispheres. The largest bamboos attain a height of 120 feet, with a diameter of a foot or more. A South American species has leaves 3 to 12 inches wide and 5 to 15 feet long. In India are extensive bamboo forests, and in countries where these grasses abound they are employed for many purposes. They furnish material for the complete construction and furnishing (including domestic utensils) of houses. They are used in shipbuilding and in the construction of bridges. Buckets, pitchers, flasks, and cups are made from sections of the stems. Baskets, boxes, fans, hats, and jackets are made from split bamboo. Ropes and Chinese paper are made from these grasses. A Chinese umbrella consists of bamboo paper, with a bamboo handle and split bamboo for a frame. The leaves are used for packing, filling beds, etc., and occasionally serve as fodder for stock. The young shoots serve as a vegetable. Tabashir, or bamboo manna, a silicious and crystalline substance which occurs in the hollow stems of some bamboos, is regarded as possessing medicinal properties. Good drinking water collects in quantities in the hollows of the internodes of many of the larger bamboos. All sorts of agricultural implements, appliances for spinning cotton and wool or for reeling silk, are often constructed entirely from bamboo. Very many articles of household use or decoration made from bamboo have become articles of commerce in Europe and this country. So many and varied are the uses of the several species of bamboo, that it is possible to mention here only a small part of them. Bamboos are propagated by seed, but more often by cuttings. Plants from the seed do not attain a sufficient growth to admit cropping under 10 or 12 years.

No. 44. Beckmannia erucæformis (L.) Host. Slough-grass. (Fig. 16.)

A stout, erect, subaquatic perennial, 1 to 4 feet high, with narrow, densely flowered panicles. The leaves are broad and flat, and the stems are coarse but tender, becoming somewhat woody when old. It grows along the banks of streams and rivers and frequently follows the course of the irrigating ditches. When young, however, this grass is palatable and readily eaten by stock. In some portions of the Northwest, to which region this grass is confined in this country, it often occurs in such quantities as to constitute an important part of the forage of low pasture lands. It may be recognized by the peculiar, spike-like branches of the panicle, which have some resemblance to the rattles of a rattlesnake, and for this reason it is sometimes called "Rattlesnake-grass." It is deserving of trial under cultivation for low meadow lands in the more Northern States, and is especially adapted to irrigated alkaline lands.

Fig. 16.—Slough-grass (*Beckmannia erucæformis*).

No. 45. Bouteloua curtipendula (Mx.) Torr. Side Oats. (Fig. 17.)

This is among the tallest of our species of *Bouteloua*, the rather stout, tufted stems being from 1 to 3 feet high. It has tough, perennial, fibrous roots, flat, long-pointed leaves, and many short spikes arranged along the upper portion of the stem. Its range extends from New Jersey westward to the Rocky Mountains and southward through Texas into Mexico. Where abundant, it is said to make fair hay, and the numerous root leaves afford good pasturage. The hay is readily eaten by stock, but on the range cattle show a decided preference for Blue Grama. Several species of Grama have been successfully grown in small cultures at some of the experiment stations, but none of them, although apparently most valuable as pasture grasses for the semiarid regions, have been introduced into general cultivation.

Fig. 17.—Side Oats (*Bouteloua curtipendula*).

No. 46. Bouteloua eriopoda Torr. Black Grama.

This is one of the species of Grama so valuable for grazing in New Mexico and Texas. The slender stems are 1 to 2 feet high, and from its thrifty habit of growth it forms dense and excellent pasturage wherever it grows abundantly. It is a common grass along the Rio Grande and in the region between the Pecos and the Gila; also in the Olympia, Guadalupe, and Eagle mountains, and on the Staked Plains in Texas. The woolly-jointed stems at once serve to distinguish this from the allied species of *Bouteloua*.

No. 47. Bouteloua oligostachya (Nutt.) Torr. Blue, or White Grama. (Fig. 18.)

This is one of the most abundant and most valued of the Grama grasses, and extends from Wisconsin westward to California, and southward into Texas and northern Mexico. It is a perennial, 6 to 18 inches high, its strong rhizomes and numerous

root-leaves forming dense and more or less extensive patches of excellent turf. In Montana it is known as Buffalo-grass. It frequents the bench lands of that State, growing at elevations of from 3,000 to 4,000 or 5,000 feet, and not infrequently covers wide areas. No other grass better withstands the tramping of stock, and it is unsurpassed for grazing purposes. In the early days in the Southwest it formed a large proportion of the hay delivered at the various military posts and stage stations, and was considered the best obtainable there. Like the true Buffalo-grass, it cures during the dry season in the turf into perfect hay, losing none of its nutritious properties.

No. 48. Bouteloua polystachya Torr. Low Grama.

This is a small, slender grass, of good quality. It is one of the smallest of the Gramas, and only occurs sparingly here and there in scattered tufts. It rarely exceeds 6 inches in height, and is confined to the arid regions of the Southwest.

FIG. 18.—Blue, or White Grama (*Bouteloua oligostachya*).

No. 49. Bouteloua repens (HBK.) Scribn. Creeping Grama.

A common grass in the vicinity of Acapulco, Mexico, where, according to Dr. E. Palmer, it occurs on the highest mountains and down their stony slopes to the water's edge. Greedily eaten by stock.

No. 50. Bouteloua texana Watson. (Seed Mesquit.)

This is a small but excellent grass, common about San Antonio and at other points in Texas, chiefly along the Rio Grande. It is recognized as an important grass in the stock ranges.

No. 51. Brachypodium japonicum Miq. Japanese Wheat-grass.

A promising Japanese perennial, closely resembling Bearded Wheat-grass (*Agropyron caninum*), but of rather stronger growth. It was introduced into California by the Agricultural Experiment Station of the University of California, at Berkeley, from New Zealand, in 1886, and the first seed was distributed in California in 1889. It has been cultivated with success at a number of points in California and at several of the experiment stations in the East. In the Southern States it is regarded as a valuable grass for winter grazing, as it makes its best growth during the cooler months.

No. 52. Briza media Linn. Small Quaking-grass. (Fig. 19.)

An erect perennial, from 1 to 2 feet high, introduced into this country from Europe because of its pleasing ornamental appearance. It has escaped from cultivation in many places, and has become sparingly naturalized. It is occasionally cultivated for ornament; the nodding panicles of rather showy spikelets are used for winter bouquets. It is but little known here, but is classed as a valuable meadow grass in Middle Europe and is recommended as an admixture for pastures on dry, thin soils. *Briza minor* is a smaller and more delicate annual species, also cultivated occasionally as an ornamental and for dry bouquets. *Briza maxima*, also an annual, is a larger ornamental species.

No. 53. Bromus ciliatus Linn. Swamp Chess.

A native perennial of wide range, frequent in open woodlands, growing to the height of 3 to 5 feet. It is leafy to the top, and would doubtless make a hay grass of

good appearance, although of somewhat inferior quality. No attempts have been made to cultivate it for agricultural purposes. It makes a vigorous early growth on good soils and is recommended for propagation in wooded parks and woodland pastures.

No. 54. Bromus inermis Leyss. Smooth Brome-grass. (Fig. 20.)

An erect perennial, 2 to 5 feet high, with strong creeping rootstocks, and a loose open panicle, 4 to 6 inches long. A native of Europe introduced into this country by the Agricultural Experiment Station of the University of California about 1880, which gives considerable promise of value both for hay and pasturage. It is strongly stoloniferous, and quickly makes a thick, firm turf. It appears to grow with equal vigor in Canada and in Tennessee, remaining green throughout the winter season in the latter State. The strong perennial character of

FIG. 19.—Small Quaking-grass (*Briza media*).

FIG. 20.—Smooth Brome-grass (*Bromus inermis*).

this Brome-grass and its unusual drought-resisting powers are qualities which recommend it for general cultivation, particularly in the semiarid regions of the West and Northwest. It thrives well on dry, loose soil, but of course the better the soil the greater the yield. Its nutritive value is comparatively low, and before undertaking its cultivation the fact should be remembered that it is somewhat difficult to eradicate when once established, although by no means so difficult as Couch-grass or Johnson-grass. In Europe it is classed among the best hay grasses. The seeds are quoted in New York catalogues at from $20 to $22 per 100 pounds. A bushel weighs about 14 pounds. Sow three bushels to the acre if sown alone. In this country the yield of seed per acre has been 600 pounds, which at the prices named would make it a very profitable crop. Professor Fletcher, of Canada, reports a yield of 3¼ tons of hay per acre.

No. 55. Bromus pumpellianus Scribn. **Western Brome-grass.**

A native of the Northwestern States in the Rocky Mountain region, extending into Canada. In habit of growth it closely resembles Hungarian, or Smooth Brome-grass (*B. inermis*), and is doubtless equally valuable. Prof. James Fletcher, who has cultivated this grass at the experiment station at Ottawa, Canada, says, "This is a very valuable grass, producing an abundance of leaves, continuing in flower for a long time, and giving a heavy aftermath."

No. 56. Bromus racemosus Linn. Upright Chess.

An introduced annual, 1 to 3 feet high, with more or less spreading and nodding panicles and smooth spikelets. This is a very common grass in cultivated fields and waste places, and is often mistaken for Chess, from which it differs chiefly in its narrower panicles and straight awns, which are nearly as long as the

Fig. 21.—Chess (*Bromus secalinus*).

Fig. 22.—Rescue-grass (*Bromus unioloides*).

flowering glumes. This grass has become very common in certain sections, particularly in the South. A field of it presents an attractive appearance, and the hay produced is of good quality.

No. 57. Bromus secalinus Linn. Chess; Cheat. (Fig. 21.)

A well-known, weedy, annual grass, introduced into this country many years ago, and now common in grain fields and waste lands. The panicle is spreading and more or less drooping, and the awns of the flowering glumes are usually much shorter than the glumes themselves and more or less flexuose. The idea that Cheat or Chess is degenerated wheat has no foundation whatever in fact. Only Cheat seeds will produce Cheat, and it is certain that wherever these plants appear they were preceded by Cheat seeds, which may have been introduced with the grain sown, or brought by birds or animals from other fields. Cheat and wheat are only remotely related; they belong to quite distinct tribes in the grass

family; wheat is less likely to change into cheat in a single generation than into the more nearly allied oats, or than wheat is to change into barley, with which it is very closely related.

No. 58. Bromus unioloides Willd. Rescue-grass. (Fig. 22.)

This *Bromus*, which is a native of South America, and probably also of the extreme southwestern portion of the United States, is a strong-growing grass, with rather broad, much flattened, usually bearded spikelets. It grows to the height of 1 to 3 feet, and in the more vigorous plants the branches of the nodding panicle are widely spreading. It grows rapidly, seeds freely, and dies after seeding. If, by frequent mowing or close grazing, it is prevented from going to seed, its duration may be continued over two or three years or more. If the seeds are allowed to fall, as they frequently do when mature, young plants soon appear, and a fairly continuous growth of this grass may thus be maintained. In many parts of the Southern States, where it has been most cultivated, it has come to be regarded as one of the best winter grasses, as it makes its chief growth during the cooler months of the year. Sow in August or September, at the rate of 30 to 40 pounds to the acre.

FIG. 23.—Buffalo-grass (*Bulbilis dactyloides*). *a*, female plant; *b*, male plant.

No. 59 Bulbilis dactyloides (Nutt.) Rafin. Buffalo-grass. (Fig. 23.)

This is the true Buffalo-grass of the Great Plains region, which is reported to have been much more abundant and more widely distributed in times past than it is at present. Now, however, it is known to extend from the British Possessions southward into Texas, where it is considered an invaluable grass and one of the best constituents of sheep pastures. It has a low habit of growth, rarely more than 5 or 6 inches high, and produces numerous creeping and widely spreading branches or stolons, which root at the joints, each joint forming a new tuft, and in this way the grass often covers large areas with a close mat of fine-leafed herbage, which is greatly relished by all grazing animals. As a winter forage, it is without an equal. The habit of growth of this plant is very similar to that of Bermuda-grass, but the stems and leaves are much finer and the turf formed more compact. Live roots transplanted from Nebraska to the grounds of the Department of Agriculture at Washington, D. C., have grown with remarkable vigor, and it may be possible to utilize this most palatable and nutritious grass in portions of the Eastern or Southern States.

FIG. 24.—Blue-joint (*Calamagrostis canadensis*).

No. 60. Calamagrostis canadensis (Michx.) Beauv. Blue-joint. (Fig. 24.)

A native grass common in the Northern and Northwestern States, extending clear across the continent, usually growing in moist meadows. The leafy stems are 3 to 5 feet high, and the open brown or purplish panicles have some resemblance to those of Redtop. Occasionally it is found occupying considerable areas to the exclusion of other grasses, and under such conditions it yields a large amount of excellent hay, highly prized by farmers and eaten with avidity by all farm stock. This grass grows naturally on low, moist meadows, and has succeeded well under cultivation. In the northern portion of the United States its more extended culture for hay is recommended.

No. 61. Calamagrostis cinnoides (Muhl.) Spreng. Reed Bent-grass.

A stout, reed-like grass, 3 to 5 feet high, not infrequent in low, moist grounds and swamps, ranging from New England southward to Tennessee. No attempts have been made to cultivate it, and little is known of its agricultural value. Probably of some use for low woodlands where grasses are desired for pasturage, and if it will thrive in the open it would make a most excellent hay-grass for low meadows.

No. 62. Calamagrostis hyperborea americana (Vasey) Kearn. Yellow-top.

A very common grass in low meadows and shady river banks throughout the Northwest. It affords a large amount of excellent hay if cut in proper season. A good grass for cultivation in moist, sandy meadows.

No. 63. Calamagrostis neglecta (Ehrh.) Gaertn. Pony-grass.

A rather slender, erect perennial, with narrow leaves, and a contracted, densely flowered, brownish panicle, 3 to 6 inches long. A native of Northern Europe and North America, ranging along our northern borders from Newfoundland and Maine to the Pacific, being most abundant in the Rocky Mountain region. Under experimental cultivation it has succeeded well. It is a productive grass, much liked by stock, especially horses, and is deserving a place among the cultivated species.

No. 64. Calamagrostis suksdorfii Scribn. Pine-grass.

A rather slender, erect grass, 2 to 3 feet high, with smooth stems, narrow leaves, and contracted, usually pale, straw-colored panicles. A common grass in the Northwest, growing in low pine woods or on moist mountain slopes. It is said to be one of the most common grasses in Washington, and it presents all the qualities of an excellent hay or pasture grass.

No. 65. Calamovilfa longifolia (Hook) Scribn. Sand-grass. (Fig. 25.)

FIG. 25.—Sand-grass (*Calamovilfa longifolia*).

A stout, long-leafed grass, 1 to 4 feet high, growing in sands or sandy soil along the shores of the Great Lakes and in the Missouri region of the West, extending southward to Kansas. Its very strong and far-reaching rhizomes or creeping "roots" make this an exceedingly valuable grass for binding drifting sands, or those subject to wash by swift currents or the beating of the waves. As a sand binder for interior regions of the country this grass is probably unsurpassed. Its long, tough leaves suggest a possible value for paper making.

No. 66. Campulosus aromaticus (Walt.) Scribn. Toothache-grass. (Fig. 26.)

A perennial grass with erect stems 3 to 4 feet high. Native of the Southern States from Virginia southward, growing in the wet pine barrens, possessing no agricultural value, but rather curious in appearance. The strong rootstocks are lemon-scented and have a pungent taste.

No. 67. Cenchrus echinatus Linn. Cock-spur.

A rather stout annual, with branching culms 1 to 2 feet long, and dense heads or spikes made up of 20 or more globular, spiny burs containing the spikelets. It is a weed of the fields and waste places of the Southern and Southwestern States.

No. 68. Cenchrus tribuloides Linn. Sand-bur. (Fig. 27.)

A widely distributed grass growing in sandy soils along river banks, the seashore and more or less scattered throughout the interior of the country in sandy districts. It is one of the worst of annual weeds wherever it becomes abundant. The prostrate branching stems are 1 to 2 feet long; the spikes are composed of 10 to 15 strongly spiny burs, which readily become detached and adhere to passing objects. No pains should be spared in efforts to exterminate this grass wherever it makes its appearance.

No. 69. Chætochloa glauca (Linn.) Scribn. Yellow Foxtail. (Fig. 28.)

An erect annual, 1 to 2 feet high, with flat leaves, and a bristly, cylindrical, spike-like, densely flowered panicle 1 to 3 inches long. This grass is widely distributed throughout the tropical and warmer temperate regions of the world, growing as a weed in cultivated grounds. It is especially common in the Southern States, where it continues to bloom throughout the season, from June to October. It is distinguished from *Setaria viridis* by its somewhat larger spikelets and more widely spreading yellowish bristles.

FIG. 26. — Toothache-grass (*Campulosus aromaticus*).

FIG. 27.—Sand-bur (*Cenchrus tribuloides*).

FIG. 28. — Yellow Foxtail (*Chætochloa glauca*).

No. 70. Chætochloa italica (Linn.) Scribn. Millet; Hungarian-grass. (Fig. 30.)

This grass, in some of its varieties, has been cultivated in the East for many centuries, and in some parts of India and Trans-Caucasia it still forms an important article of food. Its culture extends back to an early date in Egypt, and in the lake dwellings of the stone age it is found in such quantities that it must be regarded as the main bread supply of the prehistoric peoples (Hackel). In Europe and in this country it is cultivated to some extent for fodder and for the

seed, the latter being used chiefly for fowls. It grows rapidly, and may be cut within sixty or sixty-five days from the time of sowing. If used for fodder, it should be cut just as it begins to head, before blooming, for when more advanced it is apt to be injurious to stock fed upon it. When cut in good season it is one of the most valuable of soiling plants. German Millet, *Chætochloa germanica* (fig. 29), is only a variety of *Chætochloa italica*, distinguished by its smaller, more compact, and erect heads, the bristles of which are usually purplish. Sow 2 to 3 pecks per acre for hay. One peck is sufficient when sown for seed.

No. 71. Chætochloa magna (Griesb.) Scribn. Giant Millet. (Pl. II.)

This native millet grows in swamps along the coast from Florida to Delaware. The leaves are very broad and long, and the stems are often 8 or 10 feet in height. It is one of the most promising grasses for use in the reclamation of swampy

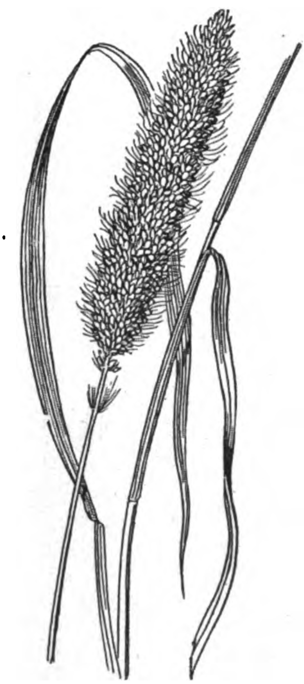


FIG. 29.—German Millet (*Chæto-chloa germanica*).

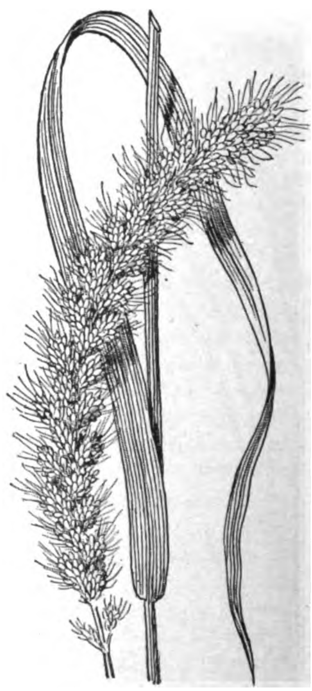


FIG. 30.—Millet (*Chætochloa italica*).

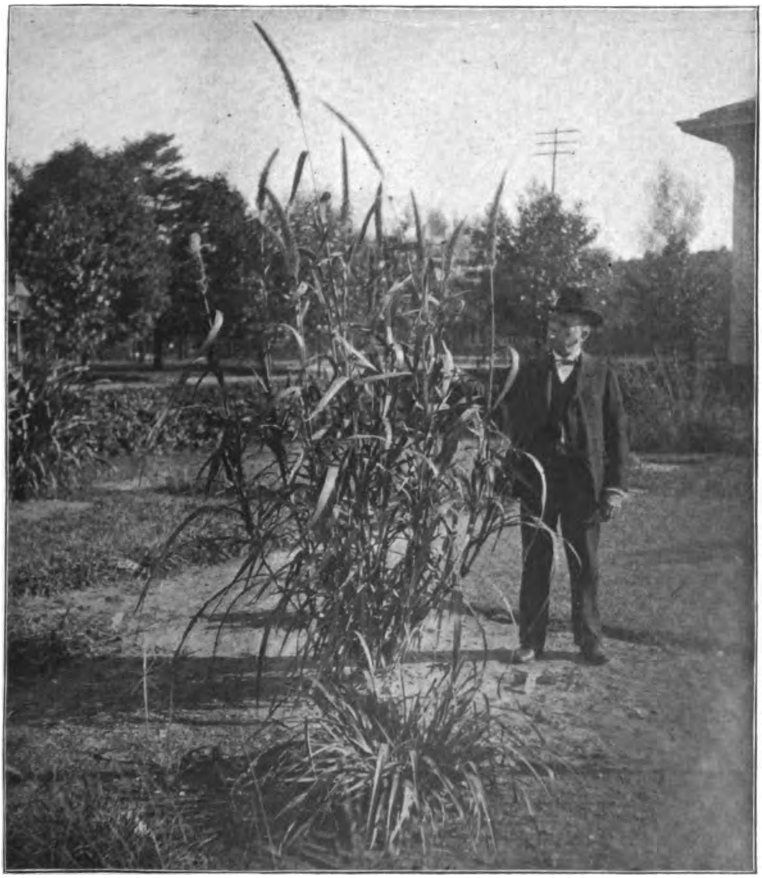
lands along the coast. It has been grown successfully in the grass garden on the Department grounds. A single plant, with much branched stems, is shown in Pl. II.

No. 72. Chætochloa verticillata (Linn.) Scribn. Bristly Foxtail.

Has about the same wide distribution as *Chætochloa glauca*, but is much less common in the United States. It is rarely found except in waste town lots and about dwellings in the Atlantic States. The bristles in this species are barbed downward, on account of which the "heads" cling to clothing or other objects with which they may come in contact. A weed.

No. 73. Chætochloa viridis (Linn.) Scribn. Green Foxtail.

Similar in habit to *Chætochloa glauca*, with about the same distribution, and equally common in this country, appearing as a weed in all cultivated grounds. It



SINGLE PLANT OF NATIVE "GIANT MILLET" IN GRASS GARDEN OF THE U. S. DEPARTMENT OF AGRICULTURE.

begins to bloom a little earlier than the Yellow Foxtail, the more numerous spikelets are smaller, the head or panicle less erect, and the bristles usually green, not yellow, as in that species. The stems are very tough and may be utilized for making paper.

No. 74. Chloris barbata Sw. Bearded Crowfoot.

This and the very similar *C. elegans* of our Southwestern States and Territories are pleasing ornamental grasses, growing to the height of 1 to 2 feet, the main stem and branches being terminated by 3 to 10 bearded spikes, which impart to them a striking appearance and make them valuable ornamentals. *C. polydactyla*, a West Indian species which has been found in southern Florida, is equally attractive, and has longer and more graceful spikes. *C. barbata* appears to be the only one generally cultivated, but there are several native species which are quite as ornamental. *C. gracilis*, a native of Central America and Mexico, is another species occasionally cultivated for ornament.

No. 75. Chloris glauca (Chapm.) Vasey. Smooth Chloris. (Fig. 31.)

A strong-growing grass, with diffusely spreading and ascending stems, 2 to 4 feet long, bearing 10 to 25 slender terminal spikes. Native of Florida, growing on brackish marshes and along the borders of cypress swamps. This is a handsome species, well deserving the attention of the florist and although not at present recognized as possessing any agricultural value, it produces a large amount of comparatively tender herbage and may prove to be a desirable fodder plant for certain localities along the Gulf coast. It has made a good growth under cultivation on clayey soil at Washington, D. C.

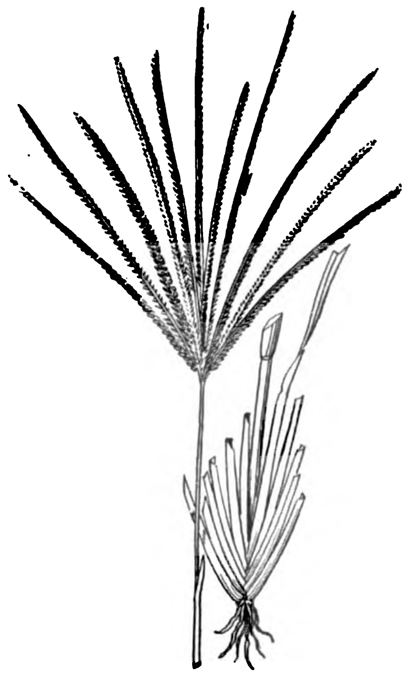


Fig. 31.—Smooth Chloris (*Chloris glauca*).

No. 76. Chloris verticillata Nutt. Windmill-grass.

A low, spreading perennial, with upright flowering branches 6 to 20 inches high. The small awned spikelets are in slender spikes, which are crowded near the apex of the stems, and become widely-spreading at maturity. This grass is common in many places in central Texas, New Mexico, Arizona, northward to Kansas, and by some is spoken of very highly as an excellent grass for grazing, and one not easily tramped out. The arrangement of the spikes gives the grass an odd and somewhat pleasing appearance, making it of some use as an ornamental species for gardens. It is a good turf-former.

No. 77. Cinna arundinacea Linn. Indian Reed.

A tall, leafy grass, 3 to 7 feet high, native and frequent in shaded swamps and damp woods or along streams in wet meadows. For such places it may possess some agricultural value, as it yields a large amount of excellent hay where growing abundantly.

No. 78. Coix lacryma-jobi Linn. Job's Tears.

This grass is a native of southern Asia, and is occasionally cultivated in this country

for ornament or as a curiosity. It is cultivated for food by some of the hill tribes of India, and supplies a staple article of diet of the Tankhul Nagas of Manipur. The female flowers of this grass are inclosed in a nearly globular, capsule-like covering, which is very hard and becomes nearly white with age. In some countries these capsules are used for dress ornamentation and by the Catholics for rosaries. In China this grass is cultivated to some extent, because the fruit is believed to be valuable as a diuretic and antiphthisis. It is a hardy annual, 2 to 3 feet high, with broad leaves and a curious, nodding inflorescence. The "seeds" may be obtained from any of the leading seedsmen.

No. 79. Cynodon dactylon Pers. Bermuda-grass. (Fig. 32.)

A grass widely dispersed over the tropical regions and warmer countries of the globe. It has a creeping habit of growth, extending over the surface of the ground and rooting at the joints. In poor soils the leaves are short and the upright flowering stems are only a few inches high, but on good land it grows to the height of 1 to 2 feet and yields a large amount of excellent hay. It may be cut three or four times during the season. In the Northern States it does not afford a profitable crop and is of little value for pasturage north of Virginia, but in the Southern States and in the warmer regions of the Southwest and on the Pacific slope it is cultivated extensively and is most highly prized, chiefly for grazing, all kinds of stock being exceedingly fond of it. It grows freely on sandy soils where other grasses will not thrive, and resists extreme drought and high temperatures. It is particularly a sun-loving grass, and will not thrive in the shade. It is useful for binding drifting sands and the loose soil of embankments or those subject to wash. It makes a pleasing lawn grass, and is extensively used for this purpose in the hotter portions of the United States, for it will thrive where the grasses ordinarily employed for lawns could not survive. The yield of hay under good conditions is from 3 to 4 tons to the acre, and as high as 10 tons to the acre have been produced under peculiarly favorable circumstances. While this grass will survive the winters of the latitude of Philadelphia, the leafage is very sensitive to cold and turns brown with the first frosts. This fact renders it objectionable as a lawn grass, except in regions where the winter season is very mild. In many portions of the Southern States there is probably no grass equal to Bermuda for summer pastures, and none which will better resist the trampling of stock. Bermuda does not mature seed except in the extreme southern portion of our country, but seed obtained from more southern latitudes is offered for sale by some of our leading seed dealers. The most direct and certain method of propagation is by transplanting, which may be effected by cutting up Bermuda turf into small pieces, scattering these along shallow furrows and covering them lightly. When once established, Bermuda grass is very persistent and difficult to eradicate, and it should not be introduced upon land which is likely to be used for other crops. New York catalogues quote the seed at $1 to $1.25 per pound, retail. In the vicinity of

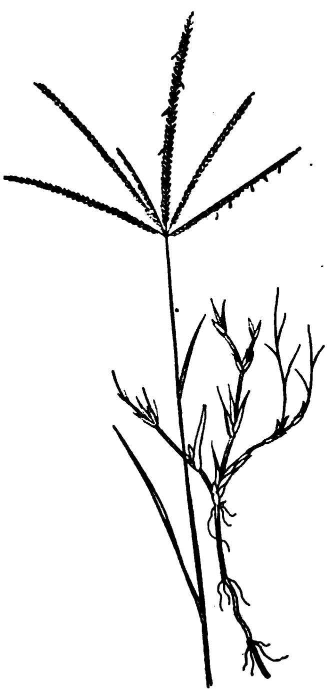


FIG. 32.—Bermuda-grass (*Cynodon dactylon*).

Washington, D. C., Bermuda-grass is known as wire grass, and in Australia it is called Couch-grass.

No. 80. Cynosurus cristatus Linn. Crested Dog's-tail. (Fig. 33).

A slightly tufted perennial grass, 1 to 2 feet high, with fine and chiefly radical leaves. It is a native of Europe and is adapted to cultivation in moist, temperate regions, and has been sparingly introduced into this country. On moist, rich land it is fairly productive, but is rarely sown alone, excepting for seed or the formation of lawns, for which latter purpose it is well adapted, as it forms an even and compact sward when thickly sown. It is said to thrive well in the shade, a fact which gives it importance to those having shaded lawns. It forms a good bottom grass, has a highly nutritive value, and is recommended for all mixtures used for permanent pastures, especially in hilly regions. The mature stems of this grass are among the most valuable of those used in the manufacture of Leghorn hats. Number of seeds in a pound of pure seed is about 1,127,000. Price of seed in New York, 40 to 60 cents per pound, or $7 to $12 per bushel of 21 pounds.

Fig. 33.—Crested Dog's-tail (*Cynosurus cristatus.*)

No. 81. Dactylis glomerata Linn. Orchard-grass. (Fig. 34.)

This is one of the best known and most popular of our cultivated grasses. It will grow well on any soil containing a reasonable amount of fertility, excepting that which is very wet. It is a hardy grass and may be grown successfully anywhere in the United States, except in the extreme South and in the arid regions of the West. It yields an abundant crop of excellent hay, and may be sown alone for this purpose, but owing to its habit of forming tufts or tussocks, the land should be seeded heavily or the seeds should be mixed with other kinds, to act as fillers or bottom grasses. It is a good pasture grass, especially for open woodlands, and affords excellent grazing earlier than almost any other species. The aftermath is unequaled in amount by any of the grasses ordinarily cultivated for hay. When sown with other grasses, the tendency of Orchard-grass to form tussocks is much diminished and the sward greatly improved. Heavy rolling is also recommended for checking or preventing the tufted growth which this grass naturally assumes. By this operation the tufts are pressed down to the level of the other grasses and the turf becomes more uniform. In old, rich meadows of Orchard-grass it is advisable to harrow in the spring and afterwards use the roller. Its best record of yield, made by Sinclair, was 27,905 pounds green, 11,859 pounds of hay, and 11,910 pounds of green aftermath per acre. Sow 3 to 4 bushels to the acre. The average number of grains in one pound of pure seed is 579,500. Price of seed, as given in New York catalogues, $3 per bushel of 14 pounds. In England Orchard-grass is known as Cock's-foot.

Fig 34.—Orchard-grass (*Dactylis glomerata*).

No. 82. Dactyloctenium aegyptium (Linn.) Willd. **Crowfoot-grass.** (Fig. 35.)

This grass, which is a weed throughout all the warmer countries of the world, has become quite common in some of the Southern States. It closely resembles the more common Goose-grass or Duck's-grass (*Eleusine indica*), from which it differs chiefly in having the terminal spikes shorter and each tipped with a sharp prolongation of the axis. It is usually found in cultivated fields, and often in such abundance as to displace the less vigorous native sorts, and is sometimes cut for hay. In parts of Africa, where this grass is common, a decoction is prepared from the seeds, which is used for inflammation of the kidneys. In Australia it is valued for pasture. In India the grain is sometimes used for food by the natives in times of scarcity. The Mohave Indians of California also use the grain for food, grinding it and making the flour into cakes or mush. (C. R. Orcutt.)

FIG. 35.—Crowfoot-grass (*Dactyloctenium ægyptium*).

No. 83. Danthonia compressa Austin. **Tennessee Oat-grass.**

A slender, erect, tufted perennial, usually growing to the height of about 2 feet, with long and narrow root-leaves, and few-flowered spreading panicles. It is a common grass in the hilly regions of New England and the Middle States, and extends southward into North Carolina and Tennessee along the mountains, where it forms the bulk of the forage of the so-called "balds" or parks which are common to mountains in the South. It is highly nutritious, as determined by chemical analysis, as well as by its effect upon the stock grazing upon it. It stands well the trampling and grazing of both horses and cattle, but sheep are too close feeders, and where these range it soon disappears.

No. 84. Deschampsia cæspitosa (L.) Beauv. **Tufted Hair-grass.**

A native perennial, ranging from New England to Pennsylvania, and westward to the Pacific Coast. It yields an inferior, coarse, harsh forage, and is not eaten by stock except when young. It has a record of producing 10,209 pounds green and 3,518 pounds dry hay per acre. Johnson, in his work on British grasses, says of the tendency of Tufted Hair-grass to form tussocks: "In the economy of nature these tufts, so unsightly and disfiguring to the landscape, are valuable by contributing to elevate and solidify low lands liable to be overflowed by rivers, and where they occur on hill and mountain slopes, by binding the spongy soil and preventing the slips which would leave them bare." This grass is most abundant in the Rocky Mountain region, where it doubtless serves to a considerable extent the purpose here mentioned. In England it is sometimes used by the farmers to make door mats. In Germany it furnishes the "Lyme-grass" used in upholstery. Price of the seed in New York, $22 per 100 pounds.

No. 85. Deschampsia flexuosa (L.) Trin. Wood-Hair grass. (Fig. 36.)

A slender perennial grass, 1 to 2 feet high, with numerous very fine root-leaves and a delicate capillary panicle. It grows in tufts like *Deschampsia cæspitosa*, and is

more common in the Eastern States than that species, but is even less valuable for meadows. It is, however, of some value for woodland pastures, as it will grow very well in the shade. It extends southward along the mountains into North Carolina and Tennessee. Its range westward is limited. It has a record of producing 12,209 pounds of rowen and 3,318 of dry hay per acre. The price of seed quoted in New York catalogues is $15 per 100 pounds.

No. 86. Distichlis spicata (L.) Greene. Salt-grass. (Fig. 37.)

An upright, wiry grass, 10 to 20 inches high, with strong, extensively creeping rootstocks. Common along the coast on both sides of the continent, and abundant in the alkaline regions of the interior, where it is often found covering considerable areas to the exclusion of other grasses. It thrives even in ground heavily crusted with alkali and other salts sufficient to destroy almost any other kind

FIG. 36.—Wood Hair-grass (*Deschampsia flexuosa*).

FIG. 37.—Salt-grass (*Distichlis spicata*).

of vegetable growth. Prospectors and miners consider its presence a sure sign of water near the surface, and when crossing the desert select spots where it grows to dig for water (Orcutt). In farming lands it is deemed a nuisance, for its tough, matted roots make a sod almost impossible to break up with a plow. Although sometimes eaten by stock in the absence of better sorts, it has little agricultural value. It is a good grass for binding loose sands or soils subject to wash.

No. 87. Eatonia obtusata (Michx.) Gray. Early Bunch-grass.

A tufted perennial, 1 to 2 feet high, with flat leaves and rather densely flowered nodding panicles. This is a native species, growing usually in moist soil, and ranging from New York to California and southward. A tender grass, readily eaten by stock, which, when abundant, supplies considerable native forage of good quality.

No. 88. Eleusine coracana (L.) Gærtn. African Millet.

An erect annual grass, 2 to 4 feet high, closely related to and much resembling our common crowfoot (*Eleusine indica*), but of rather stouter habit and with larger spikes and seeds. It is cultivated in India, southern China, Japan, and in many parts of Africa for the grain, which is used as food. It forms the principal food of many African tribes. In spite of the bitter taste of the flour, a kind of bread or unleavened cake is made of it. Beer is brewed from the grain in Abyssinia. Said to yield good crops, even on very poor soil, and may be cultivated in the same way and for the same purposes as millet. The seeds are marked with very fine, comb-like lines.

No. 89. Eleusine indica (Linn.) Gærtn. Goose-grass. (Fig. 38.)

A coarse, tufted annual, with erect or spreading stems, 6 inches to 2 feet high; spikelets arranged in a number of spikes which are clustered at the top of the stem. This grass is distributed throughout the warmer countries of the globe, and is particularly abundant in the Southern States, growing in cultivated grounds about dwellings, etc. It has somewhat wiry, flattened stems, many springing from a single root, and rather thick leaves. Some authors have spoken of it as being nutritious and good for grazing or soiling and for hay, but it is more generally regarded as a weed, and often a troublesome one in dooryards or lawns.

FIG. 38.--Goose-grass (*Eleusine indica*).

No. 90. Elymus arenarius Linn. Sea Lyme-grass. (Fig. 39.)

A stout, coarse grass, 2 to 8 feet high, with strong, creeping rootstocks, smooth stems, long, rigid leaves, and dense terminal spikes 6 to 12 inches long. The spikelets are about an inch long and three- to four-flowered. This grass is common along the seacoast of northern Europe, our north Atlantic coast, and on our Western shores from Santa Cruz, Cal., northward to within the Arctic zone. It is one of the best grasses known for binding the drifting sands of the coast, and in northern Europe has been cultivated along with Beach-grass for this purpose. These two grasses when combined seem admirably adapted for the purpose of forming a barrier to the encroachment of the sea; the sand that Beach-grass arrests and collects about itself the Lyme-grass secures and holds fast. The seeds are used for food by the Digger Indians of the Northwest, and as the grass springs up around their deserted lodges it is called by the settlers "*Rancheria*" grass. This Lyme-grass is usually regarded as possessing little or no forage value, but in very moist climates or under certain favorable conditions it may yield a valuable fodder, for when young the grass is tender and nutritious.

No. 91. Elymus canadensis Linn. Wild Rye.

A rather stout, smooth perennial, 3 to 5 feet high, with broad, flat leaves, 6 to 12 inches long. The bearded spikelets are arranged in a terminal spike or "head," which has some resemblance to a head of rye. Common in low thickets and

along streams in rich, open woods throughout the country. In the Northwest it is regarded as of some agricultural value; its cultivation is evidently worthy of trial, for if it could be successfully grown its yield of hay would be large, and, judging from appearances, the hay would be of good quality.

No. 92. Elymus condensatus Presl. Giant Rye-grass.

The largest of the native Rye-grasses, growing to the height of 5 to 10 feet. Common in the Rocky Mountain regions and on the Pacific slope, usually growing along rivers or streams the banks of which are protected and held together by the strong, spreading rootstocks of the grass. This grass is useful for holding the sand on railway banks, etc. When young this grass makes excellent hay, and when allowed to stand it affords a considerable amount of fodder for stock on the winter ranges. The seeds are used for food by the Indians.

No. 93. Elymus macounii Vasey. Macoun's Rye-grass.

A perennial grass, found quite abundantly in moist meadows, in the gravelly foothills of the northern Rocky Mountains. The culms are leafy, and this grass contributes quite largely to the native hay cut by the ranchers of the Northwest. It is apparently a very valuable species.

No. 94. Elymus mollis Trin. Soft Sea Lyme-grass.

A grass which closely resembles and has the same habit of growth as *Elymus arenarius*. It is distinguished by having the stem soft-downy just below the head or spike and in having five to seven flowered spikelets, the outer glumes of which are broader and five- to seven-nerved. This grass occurs along the shores of the Great Lakes and northward on both the Atlantic and Pacific coasts.

FIG. 39.—Sea Lyme-grass (*Elymus arenarius*).

No. 95. Elymus triticoides Nutt. Wild Wheat.

By some this has been regarded as a small, reduced form of *Elymus condensatus*, mentioned above. It grows to the height of 2 to 3 or 4 feet and is native of the Rocky Mountain region and Pacific Slope, extending eastward nearly to the Mississippi. While it is a grass of good appearance and possibly of some agricultural value, no attempts have been made to cultivate it.

No. 96. Elymus virginicus Linn. Terrell-grass. (Fig. 40.)

The most common of our native species of Lyme-grass, growing along streams, the borders of woods and thickets, more rarely in the open ground. It is an erect, smooth grass, 2 to 3 feet high, with rigid terminal spikes, which are often partly included within the upper leaf-sheath. This grass has the appearance of possessing some agricultural value; it forms an inferior turf, and by the time it blooms all the lower leaves are usually dead. When young it doubtless possesses some value as a native pasture grass. In Kansas, South Dakota, and Nebraska it is regarded a valuable grass for woodland pastures.

FIG. 40. — Terrell-grass (*Elymus virginicus*).

No. 97. Epicampes rigens Benth. Deer-grass. (Fig. 41.)

A stout, erect grass, 3 to 4 feet high, with rigid, wiry stems, and a very long, narrow, densely flowered, spike-like panicle. This grass is not uncommon in Arizona, southern California, and New Mexico, growing in sandy soil. It is regarded as one of the best native dry-land grasses, and is closely grazed wherever stock can get at it. The roots of *Epicampes macroura* — Mexican Broom-root or Mexican Whisk—are used in making brushes and are exported from Vera Cruz to Europe for this purpose.

FIG. 41.—Deer-grass (*Epicampes rigens*).

No. 98. Eragrostis abyssinica Link. Teff.

A branching, leafy annual, 2 to 4 feet high, with widely spreading capillary panicles of many spikelets. This grass grows readily from seed, which is produced abundantly, and it may be of some value for hay in parts of the South or Southwest. In northeastern Africa, where the grass is apparently native, the grain is extensively used for food, being made into bread, which possesses a slight but agreeable acid taste. There are two varieties cultivated, a white and a red variety, the former being much superior to the latter and used only by the higher classes. It is sometimes grown in gardens for the elegant panicles, which are used in bouquets. *Eragrostis neomexicana* Vasey, with the general habit of growth of Teff, occurs in New Mexico, springing up after rains, particularly in the region about Deming, where it is called "Crab-grass." It is an annual, growing to the height of 2 to 4 feet, with widely spreading, many flowered panicles, and is largely cut for hay.

No. 99. Eragrostis major Host. Stink-grass. (Fig. 42.)

A rather showy, much-branched annual, with erect or ascending stems, 6 inches to 2 or 3 feet high. This species, which is a native of Europe, has become widely distributed in this country, growing chiefly in cultivated or waste grounds, especially in light soils. When fresh it emits a strong, unpleasant odor.

FIG. 42.—Stink-grass (*Eragrostis major*).

No. 100. Eragrostis obtusiflora (Fourn.) Scribn. Mexican Salt-grass.

A rigid perennial, 12 to 18 inches high, with strong and extensively scaly rootstocks, stiff and sharp-pointed leaves, and more or less spreading panicles. Abundant in the highly alkaline soils of Sulphur Springs Valley, Arizona, where the large rootstocks serve to bind the shifting sands. In the absence of other grasses it is eaten by stock.

No. 101. Eragrostis pilosa (Linn.) Beauv. Slender Meadow-grass.

A slender branching annual, 6 to 18 inches high, with narrow, flat leaves and capil-

lary, open panicles. This grass is widely distributed throughout the subtropical and warmer temperate regions of both hemispheres. In this country it has received no attention or is regarded as little more than a weed, but in Australia and India it is spoken of as being an excellent fodder grass, and the seeds are eaten by the natives of Ajmere, India.

No. 102. **Eragrostis purshii** Schrad. Southern Spear-grass.

A native annual, similar in appearance to *Eragrostis pilosa*, and growing in similar situations. It is common from the Middle States southward, and extends southwestward into Texas and Arizona, where it exists in a great variety of forms. It grows to the height of 1 to 2 feet. It is nowhere considered of any agricultural importance.

No. 103. **Erianthus ravennæ** Beauv. Plume-grass.

A stout grass growing to the height of 8 or 10 feet, with large and plume-like panicles 10 to 20 inches long, resembling in some degree Pampas-grass. Cultivated for lawn decoration, as is also the variety with variegated leaves. A native of the Mediterranean region.

No. 104. **Erianthus saccharoides** Michx. Plume-grass.

A tall stout grass of striking appearance, 4 to 6 feet high, with a reddish or silvery-white showy panicle from 5 to 10 inches long. This grass ranges from New Jersey to Illinois and southward to the Gulf, growing in very wet places and open swamps. Of no agricultural value, but deserves notice as an ornamental grass for lawns and gardens.

No. 105. **Eriochloa aristata** Vasey. Mexican Everlasting-grass.

A branching leafy annual, 2 to 3 feet high; native of Mexico. Seed of this grass was obtained by the Department in 1888. It was cultivated in the grass garden located at Starkville, Miss., by Prof. S. M. Tracy, who says that it is a much more promising grass than *E. annulata*, more hardy, less injured by drought, and produces a heavier growth. It will make two good crops of hay annually in the South, the best crop being from the second growth, which is ready to cut in October. The grass produces an abundance of seed and reseeds itself, making its production comparatively inexpensive.

No. 106. **Eriochloa punctata** (Linn.) Hamilt. Everlasting-grass.

A quick-growing, smooth, succulent perennial, 2 to 3 feet high, with flat leaves and narrow panicles 2 to 4 inches long. Widely distributed within the tropical and subtropical regions of both hemispheres. In Australia it is regarded as an excellent pasture grass, lasting all the year round and well liked by stock. The seed, which is produced abundantly, is easily gathered. This grass deserves the attention of Southern dairymen. In Arizona it grows throughout the valleys in irrigated soil, or in the rich moist places of the plains, yielding abundant herbage eagerly sought by all kinds of stock.

No. 107. **Eriocoma cuspidata** Nutt. Indian Millet. (Fig. 43.)

A grass of rather striking appearance, 1 to 2 feet high, widely distributed throughout the Rocky Mountain region from British America southward to Texas and New Mexico, eastward to the Missouri, and westward to the Sierras of California. It grows in dry sandy soils, forming bunches of greater or less size, and from this habit of growth it has been called, along with a number of other grasses, "Bunch-grass." It thrives in soil too dry and sandy for the growth of most other grasses, and is much esteemed for grazing in the regions where it abounds. In New Mexico this grass is by some deemed superior to grama, on account of its large and nutritious seeds or grains, which are used by the Indians to some extent for food.

No. 108. Euchlæna mexicana Schrad. Teosinte. (Fig. 44.)

A stout, leafy, annual grass, 8 to 10 or 12 feet high, resembling Indian corn, to which it is botanically closely related. The variety *E. luxurians*, of the seed catalogues, which has been cultivated in various parts of the South and West, has a habit of tillering, or sending up many—20 to 50—stalks from the same root (Plate III, fig. 1). From this habit the bulk of fodder produced to the acre is very large, probably unequaled by any other grass. It is liked by all kinds of stock, and has especial value as a green fodder when other forage is dried up. It may be cut several times during the season, but nearly as good results will be obtained from a single cutting, made before there is any frost. The stalks are tender, and there is no waste in the fodder when dry or green. One pound of seed to the acre, planted in drills 3 feet apart and thinned to a foot apart in the drill, is recommended. It is a native of the warmer portions of Mexico and Central America. The seed rarely matures north of southern Florida.

No. 109. Festuca duriuscula Lam. Hard Fescue.

A slender, densely tufted, perennial grass, 1 to 2 feet high, with numerous very fine radical leaves and open panicles. This is one of the forms of Sheep's Fescue, and is of little value except in pastures. Its particular merit lies in its ability to thrive on dry sandy soils unfit for the growth of better grasses, and it well resists long periods of summer drought. It is well adapted to the cooler and mountainous regions of our country, being a native of the cooler temperate regions of both hemispheres. On well-manured, clayey land this Fescue has produced upon a single acre 18,376 pounds of green hay at time of flowering, and 8,269 pounds of hay besides 10,029 pounds of aftermath. It possesses some value as a lawn grass, but if used for this purpose it should be sown thickly and unmixed with other sorts. Sow 2½ to 3 bushels to the acre. Price of seed in New York market, $16 to $18 per 100 pounds.

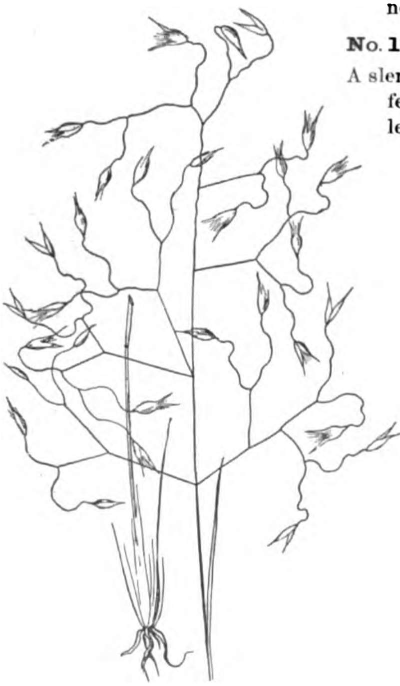


FIG. 43.—Indian Millet (*Eriocoma cuspidata*).

FIG. 44.—Teosinte (*Euchlæna mexicana*).

No. 110. Festuca elatior Linn. Tall, or Meadow Fescue.

This grass has been widely cultivated in this country, having been introduced from Europe, and has become thoroughly naturalized. It is an exceedingly valuable

FIG. 1.—YOUNG PLANTS OF TEOSINTE IN GRASS GARDEN OF THE U. S. DEPARTMENT OF AGRICULTURE.

FIG. 2.—REED CANARY GRASS IN GRASS GARDEN OF THE U. S. DEPARTMENT OF AGRICULTURE.

grass either for mowing or pasture. It is productive on soils which are not too dry, and, being of long duration, is especially valuable for permanent pastures. It thrives best on moist soils rich in humus, whether marls or clays. The variety *pratensis*, or Meadow Fescue, is a common form, rather smaller than the species, with a narrower and fewer-flowered panicle. Variety *arundinacea*, or Reed Fescue (fig. 45), is a very vigorous, tall form, 3 to 4 feet high, exceedingly hardy, and yields a very large amount of hay of excellent quality, succeeding best on lands that are comparatively moist. The seed of Meadow Fescue is quoted in some of the New York catalogues at $3.50 per bushel or $22 per 100 pounds. A bushel weighs about 14 pounds.

No. 111. Festuca heterophylla Lam. Various-leafed Fescue.

A rather slender European grass, 2 to 4 feet high, with very narrow (setaceous) root-leaves, and narrow but flat culm leaves. It is a perennial, closely related to Creeping Fescue, of which it has been made a variety by some authors. The panicle is comparatively large, open and nodding at the apex. It is a species preferring a rather mild climate, and grows naturally in open woodlands or along their borders. It makes its best growth on low-lying lands which are not too dry, but upon good soil it withstands protracted periods of drought very well. Owing to the great production of fine root leaves, this species makes a good bottom grass, and as these leaves are quite soft the grass is well adapted for lawns, and is particularly recommended for those which are too much shaded for the successful growth of other lawn grasses. It is an excellent grass, also, for woodland parks where the soil is not sandy. European authorities have classed it with the best forage plants. It is little known in this country, but the seed is offered for sale by our leading seedsmen, the retail price being from $2.75 to $3 per bushel of about 14 pounds.

FIG. 45.—Reed Fescue (*Festuca elatior arundinacea*).

No. 112. Festuca kingii (S. Wats.) Scribn. King's Fescue.

A tall diœcious bunch grass, common in the foothills and canyons of Colorado and Montana. It is a very robust species, and supplies a large amount of good though coarse winter forage. Growing naturally at an elevation of 7,000 to 8,000 feet, it might prove valuable in cultivation in similar localities.

No. 113. Festuca ovina Linn. Sheep's Fescue.

Sheep's Fescue exists in many varieties in the Northwestern States, especially in the Rocky Mountain region. Some of these varieties attain the height of 2 or 3 feet, but for the most part they are rarely more than a foot high, producing a large amount of fine herbage, which is valuable for grazing, especially for sheep. Some of the native varieties are well worthy the attention of the agriculturist. All the forms of *Festuca ovina* are "bunch-grasses," and are devoid of the creeping roots, the presence of which distinguishes the Red Fescue (*Festuca rubra*) from this species. Sheep's Fescue is well adapted for cultivation on light, dry soils, especially those which are shallow and silicious. Although a native of this country, our seed supply comes mostly, if not entirely, from Europe, where

the grass is also native. Sow 2½ to 3 bushels per acre. The weight of a bushel of seed is about 14 pounds. Price per bushel, $2.25 to $2.75 in New York.

No. 114. Festuca rubra Linn. Red Fescue.

This grass grows along the Atlantic coast of the New England and Middle States, and in the Northern States, extending westward to the Pacific. Like *Festuca ovina*, it presents many forms, but in some respects is superior to that species, as by its creeping rhizomes it will form a compact and durable turf. On account of this habit of growth, it is a useful grass for binding moving sands along the seacoast, or covering gravelly banks and dry slopes. In Germany, Red Fescue is regarded as one of the most valuable grasses for dry, sandy meadows. Owing to the great production of fine root leaves, this species makes a good bottom grass, and as these leaves are quite soft the grass is well adapted for lawns, and is particularly recommended for those which are too much shaded for the successful growth of other lawn grasses. It is an excellent grass also for woodland parks where the soil is not sandy. European authorities have classed it with the best forage plants. It is little known in this country, but the seed is offered for sale by our leading seedsmen, the retail price being from $2.50 to $3 per bushel of about 14 pounds. A variety, *F. rubra glaucescens* Hack. (fig. 46), is the best pasture grass in the mountain meadows of North Carolina and East Tennessee.

FIG. 46.—Tennessee Fescue (*Festuca rubra glaucescens*).

No. 115. Festuca scabrella Torr. Great Bunch-grass. (Fig. 47.)

A strong perennial, growing in large tufts or bunches 1 to 3 or 4 feet high. A native of the Rocky Mountain regions, extending from Colorado northward and westward to California and Oregon. It often occupies extensive mountain parks, to the exclusion of other grasses, where it affords excellent grazing. It may be cut for hay, of which it furnishes a large amount, excellent in quality, especially for horses. It is one of the best grasses for winter stock ranges. In the Northwest, particularly in the Rocky Mountain region, there are many native species of the genus *Festuca* which are well deserving the attention of stockmen and farmers.

FIG. 47.—Great Bunch-grass (*Festuca scabrella*).

No. 116. Festuca tenuifolia Sibth. Slender Fescue.

A low and fine-leafed grass, in habit of growth resembling *Festuca ovina*, of which it is regarded as only a variety by most authors. It has no special agricultural value, but will grow in dry and comparatively sterile soil. Its fine, hair-like leaves and densely cespitose habit of growth render it a good lawn grass when properly treated, especially for shady places, and it is also a good plant for edgings.

No. 117. Fourniera mexicana Scribn. Mexican Lawn-grass.

A low, extensively creeping grass that grows in the mountain valleys of western Mexico. Stock eat it with avidity. An excellent lawn and pasture grass for subtropical regions.

No. 118. Gynerium argenteum Nees. Pampas-grass.

A stout perennial, 8 to 12 feet high, with mostly radical, narrow leaves 3 to 6 feet long, and showy, silvery white or rose-red panicles 15 to 30 inches long. A much-prized ornamental for lawn decoration. The handsome panicles are used for dry bouquets. Growing Pampas plumes is an important industry in some parts of California. These plumes or panicles are cut when exposed only a few inches from the leaf sheath, then dried, and done up into bundles for shipment. Pampas-grass is a native of southern Brazil and Argentina, and there the long leaves are used for paper making, and a decoction of the rhizome is used as a diuretic. *G. roseum* is a horticultural variety, with pale, rose-colored plumes. *G. variegatum* is a form with variegated leaves.

No. 119. Hilaria cenchroides HBK. Curly Mesquit. (Fig. 48.)

A delicate perennial with slender, creeping stems, the upright, leafy shoots a few inches to nearly a foot high. This is one of the most valuable of the grasses of the dry plains and mesas of the Southwest. It forms a dense, green sward, and in habit of growth closely resembles the true Buffalo-grass. It has the habit of creeping over the ground and rooting at the joints of the stems, from which spring leafy branches that in turn reach out for other places in which to take root. It makes a thick mat of leafy turf during the summer, matures on its roots, and in the fall and winter, when not rotted by late rains, affords excellent pasturage for all classes of stock. No grass stands the long dry spells to which the Southwest is periodically subject better than the Curly Mesquit. At such times it dries up and appears dead, but in a few hours after a warm rain it becomes green to the end of the smallest branches. It is best propagated by transplanting the runners. Seed is produced in abundance, but is both difficult to harvest and of rather uncertain vitality.

FIG. 48.—Curly Mesquit (*Hilaria cenchroides*); *a*, group of spikelets; *b*, spikelet; *c*, *d*, florets.

No. 120. Hilaria mutica Benth. Black Bunch-grass.

This is a rather coarse perennial, with creeping rootstocks, and stems 12 to 18 inches high. It is common on the dry mesas of New Mexico and Arizona, extending eastward into Texas and Indian Territory. Where abundant it is regarded as one of the most valuable native grasses and furnishes excellent pasturage at all

times when not covered with snow, and is frequently cut for hay. It forms dense patches of greater or less extent on hillsides, mesas, and plains. It is also called "Black grama," and is largely gathered for hay, being uprooted with a hoe. (Pringle.)

No. 121. Hilaria rigida (Thurb.) Scribn. Galleta. (Fig. 49.)

Fig. 49.—Galleta (*Hilaria rigida*).

In the driest regions of southern California and Arizona, growing in the deserts where other grasses are rarely seen. It has coarse, much-branched, and woody stems, 2 feet high or more, growing in great clumps, resembling in its habit some of the dwarf bamboos. The stems and leaf sheaths are clothed with a dense, white-matted pubescence, which gives to the grass a peculiarly striking appearance. In the regions where it grows it is regarded as valuable forage for pack animals and mules, there being little other vegetation which they can eat. Without this grass miners and prospectors would find great difficulty in traversing the arid mountain and desert regions of the Southwest, since scarcely any other forage plants occur in the districts occupied by it (Orcutt). The Hilarias, of which we have four species, are grasses peculiarly adapted for growth in the drier lands of the Southwest, and although they are, with the exception of *Hilaria cenchroides*, wiry and tough, the forage they afford is very acceptable in the absence of more succulent plants.

No. 122. Holcus lanatus Linn. Velvet-grass. (Fig. 50.)

A perennial, 1 to 2 feet high, with a creeping rootstock, and stems and leaves clothed all over with a soft, whitish pubescence. This grass has been introduced into this country from Europe, and has become naturalized in many places. It possesses little nutritive value, and is not well liked by stock, particularly horses. It possesses some value, however, on peaty or sandy soils where the better grasses will not grow. Its cultivation, however, is not recommended. It is entirely unsuited for lawns.

Fig. 50.—Velvet-grass (*Holcus lanatus*).

No. 123. Holcus mollis Linn. Creeping Soft-grass.

Closely allied to Velvet-grass, and said to be similarly well adapted to light, sandy forest lands. It is occasionally found in the Eastern States, the seed having been introduced with that of other grasses from Europe, as both *Holcus mollis* and *Holcus lanatus* are often used to adulterate the seeds of more expensive grasses, especially the so-called prepared mixtures

of seedsmen. In Germany this grass is used on railway embankments, where on the poor, thin soil its strong, creeping roots form a turf which holds the earth together, thus preventing it from being washed or blown away.

No. 124. Hordeum jubatum Linn. Squirrel-tail-grass. (Fig. 51.)

A rather slender annual or biennial, usually about a foot high, growing along the sandy seashore, borders of the Great Lakes, and in the alkaline regions of the West. The long, slender awns of the glumes are widely spreading, and the head or spike is thus given the appearance of the "brush" of the fox, hence the common name, "foxtail." This grass is sometimes recommended for cultivation for ornament, and if the tops are cut off before the awns have expanded they may be used for dry bouquets; but the heads soon break up, and for this reason the grass is of little value even for ornament. It has no agricultural value, and, in fact, where it has spread in the West, as it often does along the irrigating ditches, it becomes a serious pest. Hay containing this squirrel-grass is considered nearly valueless. The sharp-pointed joints of the spike, each with several long and slender beards, stick fast in the nose and mouth of horses and cattle, often penetrating the flesh, and cases are reported where they have caused the death of these animals.

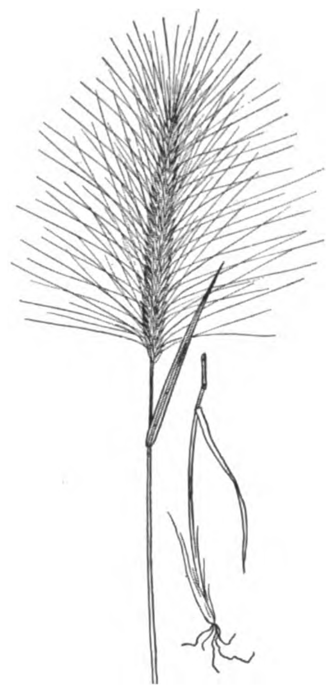


FIG. 51.—Squirrel-tail-grass (*Hordeum jubatum*).

No. 125. Hordeum murinum Linn. Wall Barley.

A coarse, tufted annual, 6 inches to 2 feet high, with dense and somewhat flattened, bearded spikes 2 to 4 inches long The beards or barbed awns are 1 to 1½ inches long and rather rigid. This grass is a native of Europe, and has been introduced along the Pacific Coast, particularly in California, where it has become a serious pest. At maturity the head or spike readily breaks up, and the groups of spikelets, which are sharp pointed at the base, adhere to almost any passing object; they work up the nostrils of cattle and into the fleece of sheep, and may do injury to the animals in much the same way as the native *Hordeum jubatum*.

No. 126. Hordeum sativum Jessen. Barley.

Cultivated barley presents many varieties, primarily divided into two-rowed, four-rowed, and six-rowed races. The varieties under these races are based upon the varied characters presented by the head, beards, or grain. All appear to have originated from *Hordeum spontaneum* Koch, which grows wild in the countries of southwestern Asia. Six-rowed barley has been in cultivation since prehistoric times in southern Europe; two-rowed barley is now largely cultivated in England and central Europe. The four-rowed barleys are of later origin than the others, and are most generally cultivated in northern Europe and in this country. The barley crop of the United States for 1895 was 87,072,744 bushels, of which amount six States produced over 73,000,000 bushels, California leading with 19,023,678 bushels. Barley is the most important cereal of the far north, some of the varieties being cultivated in Norway to latitude 70°. It is employed in making bread also in northern Asia and Japan. Barley soup is an article of diet in central Europe. From naked barley (*Hordeum decorticatum*) a

mucilaginous tea is prepared, used in medicine. The grain is largely fed to horses, both in this country and in Europe, but the chief use is for brewing beer. "Brewers grains," a by-product, both wet and dry, are fed to cattle, chiefly in the vicinity of breweries.

No. 127. Hydrochloa carolinensis Beauv. Floating-grass.

A slender aquatic grass of the Gulf States, growing along muddy banks and in shallow streams. The stems are often 2 feet or more in length, and in shallow water their summits appear above the surface, while in water of greater depth the uppermost leaves are floating. The tender stems and leaves are eaten by stock, and may afford some food for water-fowl.

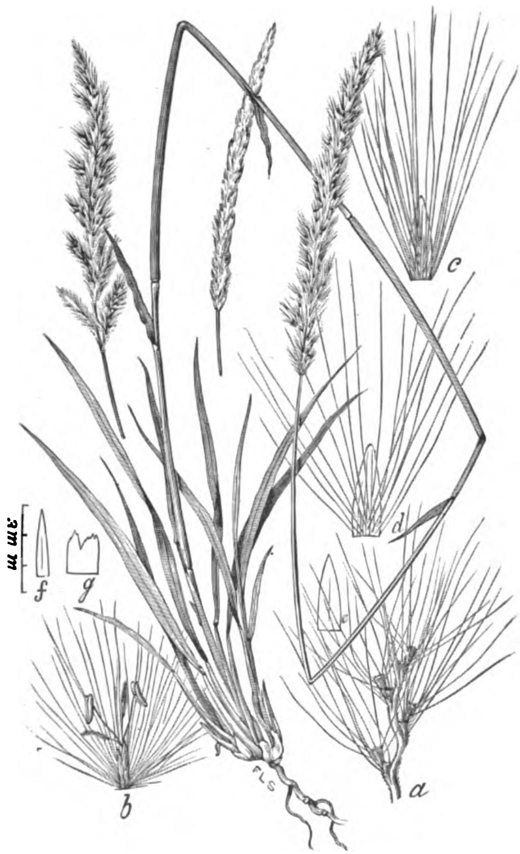


Fig. 52.—*Imperata hookeri*; *a* to *g*, details of spikelet.

No. 128. Imperata arundinacea Cyrill. Blady-grass.

A sand and soil binder common throughout the warmer temperate and tropical regions of both hemispheres. It is a stout, erect, leafy grass, 1 to 3 feet high, with silvery-white spike-like panicles. The rootstocks form a perfect network of strong fibers, and in warm countries the grass is recommended for binding river banks, the sides of dams, and the loose sands of the coast. This grass is easily propagated by root cuttings, and might be utilized along the Gulf Coast or along the Lower Mississippi in strengthening the levees. In the Malay Archipelago this *Imperata* is the principal grass of the Alang Alang fields, and is used by the natives for thatching roofs. Cattle eat it when young with apparent relish, and in Bengal it forms a very large portion of the pasturage. The Telingas make use of it in their marriage ceremonies. In western Texas and Arizona there is a native species, *Imperata hookeri* (fig. 52), very much like the one above described, in appearance and habit of growth. It grows naturally around the borders of alkaline springs.

No. 129. Isachne australis R. Br. Swamp Millet.

A slender grass, creeping at the base, the upright stems 1 to 2 feet high, with loose, open panicles of very small spikelets. It is a native of southern Asia and Australia, generally found growing along the sides of streams and on swampy ground. It is said to be liked by cattle, and Mr. Fred Turner recommends it

for planting on the banks of rivers or dams to protect them from injury by heavy rains or floods. The underground stems and roots quickly form a perfect mat in the soil, and when once established they make a very firm turf. The grass may be propagated by seeds or pieces of the root.

No. 130. Kœleria cristata (Linn.) Pers. Prairie June-grass.

This is a common grass upon the open meadows and plains of the Central and Western States, and extends beyond the Rocky Mountains to the Pacific Coast. It is one of the "bunch-grasses" of the plains region, where it is generally associated with the more common Bunch-grass, *Poa buckleyana*. On the dry bench lands it is seldom over a foot high, but in irrigated ground grows to the height of 2 feet or more, and makes excellent hay. Its cultivation is not to be recommended where better grasses may be had. However, it possesses some value for furnishing early forage, and might be used in reseeding the native pastures.

No. 131. Lamarckia aurea Moench. Golden-top.

A low annual, 3 to 12 inches high, with flat leaves and elegant one-sided panicles 2 to 3 inches long. This very attractive and favorite ornamental grass is a native of southern Europe and southwestern Asia. It is frequently cultivated in gardens, and is a pleasing grass for edgings. It has escaped from cultivation in southern California, and has become apparently spontaneous there.

No. 132. Lolium italicum A. Br. Italian Rye-grass. (Fig. 53.)

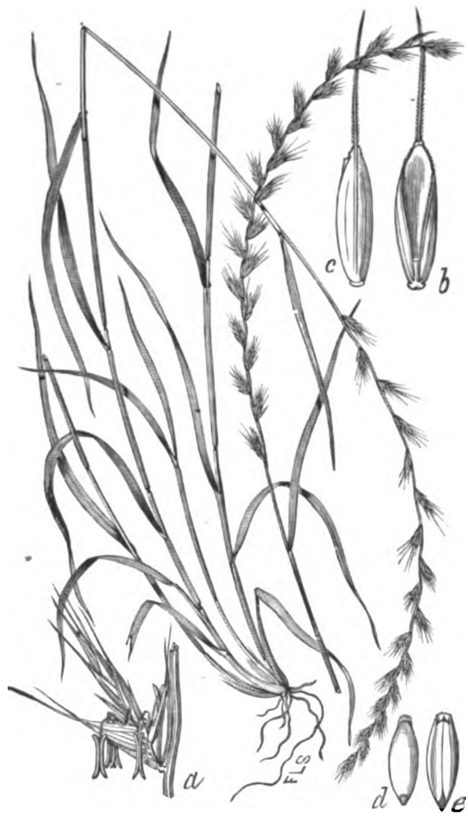


Fig. 53.—Italian Rye-grass (*Lolium italicum*): *a*, spikelet; *b*, *c*, florets; *d*, *e*, caryopsis.

A well-known and excellent grass for rich and rather moist lands, particularly for the Eastern States. It is a very rapid grower, forms a dense turf, and in Europe, whence the grass was introduced into this country, it is regarded as one of the best hay grasses. On stiff, heavy clays or on very dry soil it does not do well; but on good, calcareous loams or marls, or on moist, loamy sands, where the soil is in good condition, it is very productive, and no other grass repays manuring so well. It is not recommended for permanent pastures, as its duration is only two or three years, but it is a most excellent species for temporary meadows. Few grasses develop more rapidly than this, and where the soil is rich and its fertility maintained by applications of liquid manure, cuttings may be obtained within three or four weeks from seeding, and at intervals of a month or six weeks successive crops may be harvested. Owing to its succulent character and rapid growth, this makes one of the best grasses for soiling. Italian Rye-grass is at

once distinguished from any of the forms of perennial Rye-grass by its awned or bearded spikelets. Adulterations of the seed of Italian Rye-grass are rare, owing to its relative cheapness. The average purity of commercial seed is 95 per cent, while the germinative power is 70 per cent. The germinative power diminishes rapidly with the age of the seed. One pound of seed contains on an average 285,000 grains, and the weight per bushel varies, according to the quality, from 16 to 24 pounds. Three bushels of seed of average quality are required for sowing an acre of land. The current price in the New York market is $10 per 100 pounds.

No. 133. Lolium perenne Linn. Perennial Rye-grass.

Perennial Rye-grass has been cultivated in England for more than 200 years, and is therefore one of the oldest if not the very first grass gathered and cultivated separately for agricultural purposes. It is indigenous to Europe, North Africa, and western Asia, and was many years ago introduced into this country from England. Here it has never been so highly esteemed as in England, where the soil and climate appear to be especially well adapted to its growth. Moist and rich loams or clays are the soils best suited to it, as with Italian Rye-grass, it responds promptly to the application of quick manures. For pastures on heavy soils in moist climates it is especially valuable, and under such conditions is largely used in mixtures for permanent pastures. It is a good hay grass where the conditions are favorable, but in this country will never be so highly esteemed as Timothy. There are several varieties of perennial Rye-grass recognized by agriculturists. Pacey's Perennial, a vigorous form, is one of these. The average purity of perennial Rye-grass seed is given at 95 per cent, and the germinative power at 75 per cent. Good commercial seed should grade higher than this. One pound of pure seed contains on an average 336,800 grains. Of course, where the seeds are larger and heavier, this number would be considerably less. The best seed weighs from 25 to 35 pounds per bushel, and 2 to 3 bushels of seed are required per acre. The current retail price of good seed is $8 per 100 pounds.

FIG. 54. — Perennial Rye-grass (*Lolium perenne*).

No. 134. Lolium temulentum Linn. Darnel.

An annual grass, 2 to 3 feet high, having a general resemblance to Italian Rye-grass, but usually stouter, more strictly erect, with longer glumes and larger seeds. It has been introduced into this country with the seeds of other grasses, and is occasionally met with in grain fields and about dwellings. The grain contains a narcotic or poisonous principle, which causes eruptions, trembling, and vertigo in man and flesh-eating animals. If the seeds are malted with barley, the ale causes intoxication very suddenly. It is contended by some that perfectly healthy Darnel seeds are innocuous—that only grains which are ergotized or otherwise diseased are injurious.

No. 135. Manisuris. Rat-tail-grass.

The native species of *Manisuris* are branching, leafy perennials, with slender, cylindrical, many-jointed spikes, which readily break up. They are found chiefly in the pine-barren swamps of the Gulf States. They are of little agricultural value in this country. *Manisuris compressa*, a native of southern Asia, south Africa,

and Australia, where it is called Mat-grass, has creeping or ascending flattened stems, rather short leaves, and slender spikes. In some parts of Australia it is highly esteemed for pasturage, and is said to retain its greenness throughout the year in dry climates. It is not injured by light frosts. The prostrate stems sometimes attain a length of 5 or 6 feet. A closely related species, *M. fasciculata*, occurs on the lower Rio Grande.

FIG. 55.—Nimble Will (*Muhlenbergia diffusa*).

No. 136. Melinis minutiflora Beauv. Molasses-grass.

A sweet and highly nutritious species, and the most esteemed of the grasses of central Brazil, where it is native, growing upon the hills and dry lands. It is regarded a most excellent grass for dairy cows, and deserves a trial in the Southern and Southwestern States and California. The Brazilian names for this grass are "*Capim mellado*" and "*Capim gordura.*" The English name given above is a translation of these. This species occurs also in Ascension Island, Natal, and Madagascar.

No. 137. Muhlenbergia diffusa Schreb. Nimble Will. (Fig. 55.)

A low, slender, diffusely branched grass growing on dry hills, in woods, and especially in shady, waste grounds about dwellings. The leafy, wiry stems, which are from 6 to 18 inches long, spring from extensively creeping and rather tough rhizomes, which make a turf very difficult to break up. When young, this grass is readily eaten by all kinds of stock, but after it matures it is so tough that few animals will touch it. It possesses really very little agricultural value, and some look upon it rather as a weed. It is a native from southern New England to Iowa, Michigan, and southward, blooming in the latter part of summer.

FIG. 56.—Knot-root grass (*Muhlenbergia mexicana*).

No. 138. Muhlenbergia distichophylla Kth. Bearded Saccaton.

This is a strong, firmly rooted grass, 3 to 4 feet high, with rather long and rigid leaves, and a narrow panicle often exceeding a foot in length. It is frequent in the rich valleys in Arizona and New Mexico, and on rich bottom lands it is often cut for hay. It is a coarse grass, like *Sporobolus wrightii*, and by the settlers is classed with it under the general name of Saccaton. In Arizona it forms the more common "hay" that one finds in the towns and way stations, being pulled by the Mexicans or Indians and brought in on the backs of donkeys or on carts. There are many species of *Muhlenbergia* in the south western part of the United States and northern Mexico, and doubtless many of them are of considerable agricultural value. *Muhlenbergia virescens* is a soft and leafy species growing in clumps on the higher slopes of the mountains in Arizona, and with *Poa fendleriana* forms the chief herbage of the so-called "deer parks" of the mountains. (Pringle.)

No. 139. Muhlenbergia mexicana (Linn.) Trin. Knot-root grass. (Fig. 56.)

A much-branched, leafy perennial, 2 to 3 feet high, with strong, scaly, creeping rootstocks, which often do good service in binding river banks, along which this grass frequently grows. In the Northeastern States this grass is common in low meadows, where it occasionally forms a considerable proportion of the native hay of such places. If cut before the stems have become woody, which they do after flowering, the hay produced is of good quality. It ranges from New England southward to the Gulf and westward to the Rocky Mountains. In the Eastern States it blooms in August.

No. 140. Muhlenbergia porteri Scribn. Wire grama.

This grass is a native of New Mexico and Arizona, growing on the dry mesas and table-lands. It has a straggling habit of growth. The stems are 1 to 2 feet long, much branched, and often matted together. It furnishes excellent feed for cattle in the regions where it grows, and yields good hay, which is harvested in considerable abundance by the ranchmen. It withstands drought very well, but is soon run out under the continued trampling of cattle.

No. 141. Muhlenbergia pungens Thurb. Blow-out grass.

A rather rigid perennial, 12 to 18 inches high, with firm sharp-pointed leaves and open panicles. It has strong, creeping roots, and often does good service as a sand binder. In the sand-hills region of Nebraska it grows abundantly around the borders of the so-called "blow-outs," preventing their extension and assisting materially in restoring the turf. In some parts of Arizona where it occurs it is esteemed a valuable forage plant. It grows from Nebraska southward to New Mexico and Arizona, and along the Colorado River above Fort Yuma.

Fig. 57. — Wild Timothy (*Muhlenbergia racemosa.*)

No. 142. Muhlenbergia racemosa (Michx.) B. S. P. Wild Timothy. (Fig. 57.)

An upright, usually sparingly branched perennial, 2 to 3 feet high, with densely flowered, narrow panicles 2 to 4 inches long, often resembling those of timothy. The rootstocks are very tough, and closely covered with thickened scales. It frequents bogs and low grounds from New England westward to the Rocky Mountains, extending southward to Tennessee, New Mexico, and Texas. It is little prized in the East, but in the Northwestern States is recommended as an excellent grass for hay.

No. 143. Opizia stolonifera Presl. Mexican Lawn-grass.

An extensively creeping, diœcious grass, the very slender, prostrate stems sending up leafy tufts 1 to 4 inches high. Similar in habit to Bermuda, but more delicate. According to Dr. E. Palmer, this is one of the most important grasses of Mexico. Growing close to the ground, it forms a thick sod over all exposed surfaces, even over the cobblestones in the streets of towns. It is used in the public squares with good effect. By regular watering it is easily kept green, and but little cutting is necessary. The seed is difficult to obtain, owing to the constant nibbling of domestic animals. Propagation by cuttings of the rooting, prostrate stems is probably the best method. Trials with this grass ought to be undertaken in the Southern States, both for lawns and pastures.

No. 144. Oplismenus setarius R. & S. Creeping Beard-grass.

A slender perennial of the Gulf States, with decumbent or creeping stems, and short and rather broad leaves. It possesses no recognized agricultural value, but as it grows naturally under the dense shade of trees it might be used for covering the ground in shady places where other grasses will not thrive. It can be propagated by pieces of the stem, which root at the joints, and if cared for, will in a short time make a good turf. A closely allied grass of similar habit of growth, with variegated leaves, is often grown in greenhouses for its ornamental appearance.

No. 145. Oryza sativa Linn. Rice.

A tropical or subtropical, semiaquatic grass, the grain of which is the staple food of one-third of the human race. It is most extensively cultivated in southern Asia, China, and Japan. The annual produce of these countries is estimated at 100,000,000 tons. The rice-growing districts of China support the densest population in the world. In this country rice is cultivated in the States of South Carolina, Georgia, Louisiana, and Texas. The estimate of the crop of cleaned rice produced in Louisiana in 1895 was 82,436,832 pounds. "Paddy" is the grain in the husk. There are many varieties of rice, distinguished by color or size of the grain, absence or presence of beards, etc. There are two classes known as "lowland rice" and "upland rice." The latter is cultivated to some extent in western Tennessee. Rice straw is used for making paper.

No. 146. Oryzopsis asperifolia Michx. Mountain Rice.

A perennial, 6 to 18 inches high, with very long basal leaves overtopping the stems. This grows in rich, open woods, upon hillsides, from New England to Minnesota and northward. It is one of the early blooming species, flowering in May and ripening its seed in June and July. The leaves remain green throughout the winter.

No. 147. Oryzopsis melanocarpa Muhl. Black-fruited Mountain Rice.

A rather stout, long- and broad-leafed grass, 2 to 3 feet high, with a simple panicle of a few rather large spikelets. Grows in rich, rocky woods from New England southward to Pennsylvania and westward to the Rocky Mountains, blooming in July and August. These species of *Oryzopsis* have no recognized agricultural value, but they are very hardy perennials and might be propagated .o advantage in woodland parks.

No. 148. Oryzopsis micrantha Thurb. Small Indian Millet.

A perennial, quite widely distributed throughout the central and western counties of the Dakotas and in eastern Montana. It grows in dry, sandy soil, and though tough and wiry, is nutritious and is considered a valuable grass.

No. 149. Oryzopsis miliacea (Linn.) Hack. Many-flowered Millet-grass.

A perennial, 2 to 3 or 4 feet high, with a many- and small-flowered nodding panicle, 6 to 12 inches long. It is a native of central and southern Europe, growing in dry, open woods and thickets. Was introduced into California in 1879, and has been cultivated experimentally with varying success at a number of points in that State. On the granitic soil of San Diego, California, it has grown 3 feet high without irrigation, and remained green throughout the year. Horses and cattle are said to eat it greedily. In Europe it is not regarded as possessing much, if any, agricultural value.

No. 150. Panicularia americana (Torr.) MacM. Reed Meadow-grass.

A stout, erect, leafy perennial, 3 to 4 feet high, with long, rather broad leaves, and a large, nodding panicle. It is common in the northern Middle States and southward along the mountains to Tennessee and North Carolina, extending westward to the Rocky Mountain region. It grows along streams and in moist meadows, and in such places often forms a considerable portion of the native hay. It is liked by cattle and is a good pasture grass for wet lands.

No. 151. Panicularia canadensis (Michx.) Kuntze. Rattlesnake-grass. (Fig. 58.)

A grass similar in habit to the last and growing in similar situations in the Northern States, extending southward to Pennsylvania and westward to Kansas. It is less common than *P. americana*. It has received no attention from the agriculturist. The nodding panicles of rather large spikelets are sometimes gathered for dry bouquets.

No. 152. Panicularia fluitans (Linn.) Kuntze. Floating Manna-grass. (Fig. 59.)

This grass grows to the height of from 3 to 5 feet, and has a narrow panicle composed of rather few long and narrow or cylindrical spikelets. It is a cosmopolitan species, found in all temperate regions of the world, and is regarded as one of the best fodder grasses for swampy meadows. In some parts of Europe the seeds are gathered and used for human food in the form of soups and gruels.

FIG. 58.—Rattlesnake-grass (*Panicularia canadensis*).

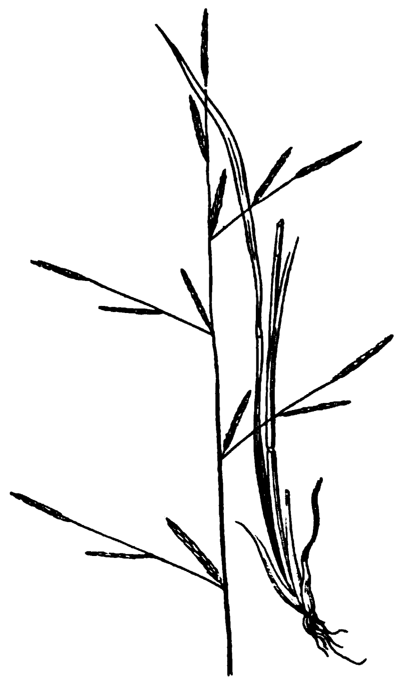


FIG. 59.—Floating Manna-grass (*Panicularia fluitans*).

No. 153. Panicularia nervata (Willd.) Kuntze. Fowl Meadow-grass. (Fig. 60.)

A leafy perennial, 1 to 3 feet high, with expanded nodding panicles of small spikelets. This is a common species in low meadows and moist grounds, extending from New England southward to the Gulf States and westward to the Pacific coast. It is a good fodder plant for moist meadows. Varies greatly in size, according to soil and location. *Panicularia americana* and *Panicularia nervata* furnish food for water fowl during the fall migrations and are valuable in game preserves along with *Zizania aquatica*.

No. 154. Panicum agrostoides Muhl. Munro-grass. (Fig. 61.)

A native perennial, with branching, leafy stems, 2 to 4 feet high, and a panicle resembling that of Redtop. It grows in low meadows and along the banks of creeks, shores of ponds, etc., and often yields a large amount of very good native

hay. In low, moist, and rather rich meadows its cultivation would doubtless be profitable, and it is certainly deserving of a trial in such locations.

No. 155. Panicum amarum Ell. Bitter Panic-grass. (Fig. 62.)

A grass of the sandy seacoasts, ranging from Connecticut southward to Florida and along the Gulf. It has coarse, hard stems, 1 to 5 feet high, and strong, creeping rootstocks, making it an excellent sand binder. The islands off the coast of Mississippi are almost wholly made up of drift sands, the outer sides being dunes from 10 to 30 feet high, while the middle of the islands is usually low and occupied by swamps or lakes. This bitter panic is very abundant upon the outside of these dunes, where it is exposed to the winds and waves, and where it serves to effectually bind the otherwise shifting sands. The leaves and stems have a bitter taste, hence the common name.

FIG. 60.—Fowl Meadow-grass (*Panicularia nervata*).

FIG. 61.—Munro-grass (*Panicum agrostoides*).

FIG. 62.—Bitter Panic-grass (*Panicum amarum*).

No. 156. Panicum capillare Linn. Old Witch-grass.

An annual, with usually coarse, branching stems, 1 to 3 feet long, hairy leaf sheaths, and widely spreading panicles. Grows in cultivated grounds, where it often becomes a somewhat troublesome weed. Being an annual, however, it is easily eradicated. Possesses no value for fodder excepting for fall feed on stubble.

No. 157. Panicum ciliatissimum Buckl. Indian Wheat.

A more or less extensively creeping perennial, with short leaves and upright flowering stems, 6 to 18 inches high. The panicles are narrow and few flowered, and in the prostrate forms usually partly included within the leaf sheaths. This grass is a native of western Texas, and doubtless possesses some agricultural value for the drier regions of the Southwest. The creeping stems resemble somewhat those of Bermuda-grass, but the leaves are usually more crowded and broader in proportion to their length.

No. 158. Panicum colonum Linn. Shama Millet.

A native of the tropical and warmer temperate regions of the Old World. In northern India it is considered one of the best fodder grasses. Introduced into the Southern and Southwestern States, where it is occasionally found in waste grounds about dwellings. It is closely related to *Panicum crus-galli*, differing from that grass in its smaller size and more simple inflorescence. The stems and leaves are tender and readily eaten by stock. In India the grain, which is produced abundantly, is sold in the markets and used for food.

No. 159. Panicum crus-galli Linn. Barnyard-grass. (Fig. 63.)

This well-known annual of rank growth is common in rich, cultivated ground, especially around dwellings. There are several forms presented by this species. That growing as a weed around barnyards and dwellings, in cultivated grounds in the Atlantic States, was probably introduced from Europe. There are, however, several native varieties, or possibly good species. One of these occurring in the brackish marshes or meadows along the seacoast, grows to the height of 3 to 5 feet, with the lower leaf sheaths very hirsute, and the spikelets long-awned. A tall, smooth form occurs in New Mexico, Arizona, and the Mohave desert region, springing up after the summer rains in all swampy places or lowlands. It grows to the height of 6 or 7 feet, and its seeds, which it produces abundantly, are collected by the Mohave Indians, ground into flour, and cooked for food. The poorer classes of India also use the grain for food. A variety introduced from Japan has been cultivated at some of the experiment stations and treated as a millet. At the Hatch Experiment Station, in Massachusetts, the crop produced was very uniform, averaging 7 feet in height. The yield was at the rate of 11,207 pounds of straw per acre and 66.7 bushels of seed. When sown for silage or for soiling at the rate of one peck of seed to the acre, the yield was at the rate of from 15 to 18 tons per acre. A field sown July 26, after a crop of hay was removed, yielded 12 tons per acre. It is very much liked by stock, and is a valuable forage plant for feeding green or for the silo. It is not so well adapted for hay, as it is a coarse, succulent grass, and rather difficult to dry.

FIG. 63.—Barnyard-grass (*Panicum crus-galli*).

No. 160. Panicum digitarioides Carpenter. Maiden Cane.

A rather coarse grass, 2 to 4 feet high, growing along ditches, in swamps, and in moist sands from Delaware southward to Florida and along the Gulf near the coast. It has strong and widely spreading or creeping rootstocks, which are useful in binding sandy railroad embankments in the Southern and Gulf States.

No. 161. Panicum fasciculatum Sw. Brown-top.

A rather coarse and much-branched leafy annual, growing in clumps to the height of 2 to 3 feet. The leaves are flat, one-fourth to one-half an inch wide, and 2 to 6 inches long. It is a native of Texas and Florida. Similar in character and closely allied botanically to *Panicum texanum*.

No. 162. Panicum lachnanthum Torr. Arizona Cotton-grass.

This is a native of the dry regions of Arizona and New Mexico. It resembles *Panicum lanatum*, but has more slender stems, which rise from strong, woolly, and knotted rootstocks. This may prove to be a valuable pasture grass for the dry or semiarid regions of the Southwest.

No. 163. Panicum lanatum Rottb. Cotton-grass.

A variable species widely distributed throughout the tropical regions of both hemispheres. It is a perennial with slender or stout stems 1 to 3 feet high, usually with flat leaves and narrow panicles, the spikelets being densely clothed with long silky or cottony hairs, which are white, or sometimes brownish or purplish. When abundant this grass yields excellent pasturage. It has been found in southern Florida and at other points near the Gulf coast. There is a variety of this species growing in the dry regions of Arizona and New Mexico which has more slender stems, that spring from strong woolly and knotted rhizomes. Doubtless this form would be a valuable pasture grass for the dry or semiarid regions where it is native.

No. 164. Panicum maximum Jacq. Guinea-grass. (Fig. 64.)

This grass was long ago introduced into America, presumably from tropical Africa, and has for many years been cultivated in tropical South America and the West Indies. In these regions it is spoken of as being a splendid pasture grass, growing to the height of 12 feet, forming dense tufts. It is readily propagated by cuttings of the creeping rootstocks. It has been introduced into some of the Gulf States, particularly Florida, where it is highly valued. Few grasses yield a larger amount of fodder, and it may be cut as often as once a month during the growing season. If allowed to attain its full size it becomes coarse and unfit for forage. Its stems are killed by the first frosts of autumn. It seeds only in the warmest parts of the States bordering the Gulf. It is much less hardy than Johnson-grass, with which it has been confounded by some, and has quite a distinct habit of growth.

Fig. 64.—Guinea-grass (*Panicum maximum*).

No. 165. Panicum miliaceum Linn. Broom-corn Millet.

A rather coarse annual, attaining a height of 2 to 4 feet, with large, drooping, loosely flowered panicles. There are several varieties, distinguished by the color of the fruit or character of the panicle. This is the true millet which has been cultivated in the East from prehistoric times, so that now its native country is not known. It is still cultivated to a considerable extent in China and Japan, also in South Russia and Roumania, and to a limited extent in other parts of Europe and North Africa. It requires a rich soil, and under favorable conditions its growth is very rapid and its production of seed large, in some instances amounting to 60 or 70 bushels to the acre. The grain is nutritious, and is one of the best for feeding poultry. When ground, the flour makes a

rich and nutritious porridge, for which purpose it is chiefly used in the eastern countries where the grass is grown. In northern India, where the grain is largely used, a preparation of it constitutes a favorite food at marriage ceremonies. Owing to its rapid and somewhat succulent growth, it is an excellent soiling plant. It has, however, been little cultivated in this country, but is occasionally found in the older settlements in cultivated fields and waste grounds about dwellings. The number of grasses termed millets in various parts of the world is large, and includes many very different species, whose grain, however, is used for human food. Most of the so-called millets belong to the genera *Chætochloa*, *Panicum*, and *Paspalum*. They form the principal food grains of the natives of many parts of Africa and Asia. It has been estimated that the millets feed one-third of the human race.

No. 166. Panicum molle Sw. Para-grass.

A rather coarse, reed-like perennial, 4 to 6 feet high, with hairy nodes, and narrow, lax panicles, 6 to 8 inches long. It is cultivated in South America, and in the West Indies and Mexico, and has been introduced into some of the Gulf States. It is grown with success on the high pine ridges of Florida, and wherever cultivated it is most highly esteemed and regarded as a very fattening pasture grass. How far to the north this grass may be grown successfully does not appear to have been determined, but it is hardy at the Cape of Good Hope and other far extra tropical regions (Baron von Mueller). It is propagated either by seeds or root cuttings.

No. 167. Panicum obtusum H. B. K. Vine Mesquit.

A stoloniferous grass, the runners attaining a length of 8 to 10 feet, the upright flowering culms 12 to 24 inches high. This grass ranges from Colorado to Texas, New Mexico, Arizona, and southward into Mexico. It is usually found in irrigated lands or in the low, damp soil of the valleys, most frequently under the shade of trees and shrubs. No attempts have been made to cultivate this grass, but its appearance and habit of growth indicate an agricultural value of sufficient importance to call for experiments in its cultivation. In New Mexico this species is called "Wire-grass."

No. 168. Panicum plicatum Lam. Palm-leafed Grass.

A broad-leafed perennial, 3 to 4 feet high or more, native of India. The leaves are elegantly striate and usually plicate, giving to the grass an unusual and at the same time attractive appearance. It is a favorite ornamental for greenhouse culture.

No. 169. Panicum proliferum Lam. Sprouting Crab-grass.

A smooth and usually much-branched native annual, with rather coarse, spreading or ascending stems 2 to 6 feet long, flat leaves, and diffuse terminal and lateral panicles. It grows naturally in moist, rich soil along the banks of streams and rivers, around the shores of ponds and lakes, and in the South is often abundant in rich, cultivated fields, growing with Crab-grass. The stout, succulent stems are sweetish and much liked by horses and cattle. Its range is from Maine to Nebraska, and southward to the Gulf, blossoming in the latter part of summer or early autumn. The spontaneous growth of this grass in cultivated fields after the removal of crops is of some value for hay or pasturage, but its cultivation can not be recommended in view of the fact that we have many annual grasses much superior to it. In the Northern and Middle States it is classed with the weeds.

No. 170. Panicum repens Linn. Creeping Panic.

An extensively creeping grass, with rather stiff upright stems, 1 to 2 feet high or less. It is common in the maritime districts in southern Asia, northern Africa,

southern Europe, and Australia. It is also found along the shores of the Southern States bordering the Gulf, extending westward to Mexico. It has no agricultural value, but is a natural sand binder. Upon the sandy islands lying off the Gulf Coast it grows abundantly upon the outside of dunes, protecting them from the action of the winds and waves.

No. 171. Panicum sanguinale Linn. Crab-grass. (Fig. 65.)

A well-known annual, common in nearly all parts of the United States, growing in cultivated fields and about dwellings. It is a weed in gardens and among hoed crops. In grain fields after harvest it frequently springs up in such quantity, particularly in the Southern States, as to yield one or even two good cuttings of hay. This spontaneous growth affords excellent pasturage, as well as hay of first quality if properly cured. The stems are much branched, and in good soil attain a length of 3 to 4 feet. This grass contains little fiber, and dries quickly when cut, but if after cutting it is wet by rains or heavy dews its value for hay is almost wholly destroyed. In Bohemia, Crab-grass is cultivated upon sandy soils and the grain is used for food in the form of mush or porridge.

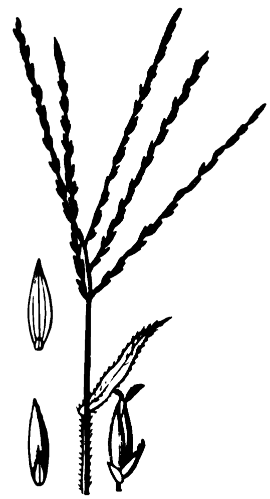


FIG. 65.—Crab-grass (*Panicum sanguinale*).

No. 172. Panicum serotinum (Michx.) Trin. Little Crab-grass. (Fig. 66.)

A species related to Crab-grass (*Panicum sanguinale*), common in the Southern States near the Gulf, disputing with Louisiana-grass the claim of being the most valuable native pasture grass of that section. It is probably a biennial. It is much like Crab-grass, sending out leafy, creeping shoots at every joint, but is smaller in every way, with shorter and more hairy leaves of a lighter green color. It is invaluable for pasturage, forming a close turf, and driving out nearly all other plants. It grows best in sandy soil where there is a little moisture.

FIG. 66.—Creeping Crab-grass (*Panicum serotinum*).

No. 173. Panicum spectabile Nees. Angola-grass.

A stout grass, 3 to 5 feet high, with rather broad and long (1 to 2 feet) leaves, and a terminal, densely flowered, compound and narrow spike 8 to 10 inches long. Imported into South America many years ago from the west coast of Africa (the region of Angola). It is cultivated on the low lands in the eastern part of Brazil, particularly in the region of Rio de Janeiro, where it is called "Capim d'Angola." This Panicum is closely related to and resembles some forms of Barnyard-grass (*P. crus-galli*). It is spoken of as an extremely productive and nutritious fodder-grass, and may prove valuable for the low regions along the Gulf coast.

No. 174. Panicum sulcatum Aubl. Palm-Leafed-grass.

A South American perennial, 4 to 6 feet high, with palm-like leaves 1 to 2 inches broad and 16 to 20 inches long, and long, terminal, narrow panicles which taper above and below. The leaves of this grass are deeply sulcate or plicate, like those of the Indian *P. plicatum*. Sometimes cultivated for ornament in green-houses or upon lawns.

No. 175. Panicum texanum Buckl. Colorado-grass. (Fig. 67.)

A branching, leafy annual, 2 to 4 feet high, with a narrow panicle 6 to 8 inches long terminating the main stem and branches. It is nutritious, of rapid growth, and upon good soil yields a large amount of excellent hay, and may be cut twice or even three times during the season. It reseeds itself readily. It prefers rich,

FIG. 67.—Colorado-grass (*Panicum texanum*).

FIG. 68.—Switch grass (*Panicum virgatum*).

alluvial soil along river bottoms, etc., and upon such land withstands drought well. In certain parts of Texas, particularly in the counties along the Colorado River, in the central part of the State, where it appears to be native and where it often comes up in cultivated fields after the removal of corn or other grain crops, it is spoken of in the highest terms as a hay-producing grass.

No. 176. Panicum virgatum Linn. Switch-grass. (Fig. 68.)

A tall, native perennial, 3 to 5 feet high, with strong, creeping rootstocks, long, flat leaves, and ample, spreading panicles. When young this affords good grazing, but at maturity the stems become hard and practically worthless for fodder. It ranges from Maine southward to the Gulf and westward to the Rocky Mountains. It is particularly common near the coast in sandy soil bordering the marshes, and oftentimes plays an important part there, in preventing the drifting of sands

by the winds or the washing of soils by overflows and high tides. On good lands it is very productive, and if cut before the stems have become hard yields a large amount of hay of very good quality.

No. 177. Pappophorum laguroideum Schrad.

A handsome ornamental, 3 to 5 feet high, with narrow, plume-like panicles a foot or more long. It is a native of Mexico, and has been successfully grown from seed on the grounds of the Department of Agriculture. It is worthy of introduction as an ornamental for gardens and lawns because of the beauty of its pale straw-colored panicles.

No. 178. Pappophorum wrightii S. Wats. Purple-grass.

A slender and apparently annual grass of western Texas, New Mexico, and Arizona, growing on the open plains and among the foothills of the mountains. It has short, narrow leaves and narrow, densely flowered heads or panicles, which are softly bearded and grayish or purplish. It is said to be fully equal to Grama or Buffalo-grass in nutritive value, and more palatable to horses or mules.

No. 179. Paspalum boscianum Flügge. Purple Paspalum.

A rather stout perennial with ascending branching stems, 2 to 3 feet high, long, flat leaves, and numerous racemes crowded near the summit of the culm and its branches. It is a native of the Southern States, growing in moist grounds, preferring rather heavy soils. Like other species of Paspalum, it grows in tufts and often occurs covering considerable areas to the exclusion of other grasses. It yields a good bulk of sweet hay, but is rather slow in drying.

FIG. 69.—Carpet-grass (*Paspalum compressum*): *a*, attachment of spikelets to rachis; *b* and *c*, spikelets; *d*, floret.

No. 180. Paspalum compressum (Sw.) Nees.

A slender, erect, or more frequently prostrate and extensively creeping perennial, rooting at the nodes, and sending up numerous leafy, flower-bearing branches, 6 to 24 inches high. The very slender racemes or spikes borne at or near the summit of the stems are 1 to 3 inches long. The prostrate creeping stems spread rapidly, and soon form a dense, carpet-like growth, crowding out all other vegetation. It withstands protracted drought, grows well on almost any soil, and in the more southern districts is evergreen, yielding good pasturage both summer and winter. It is regarded as one of the most valuable native pasture grasses of the regions bordering the Gulf, and is a most excellent lawn grass, superior to Bermuda and less difficult to eradicate. It is found in the warmer regions of both North and South America. It is readily propagated by sets and seeds.

No. 181. Paspalum dilatatum Poir. Large Water-grass.

A rather coarse leafy perennial, growing in clumps 2 to 5 feet high, bearing near the summit of the stems two to ten, more or less spreading racemes or spikes of crowded, hairy spikelets. It is a native of Brazil and possibly was originally introduced into the Southern States (where it has become quite widely distributed) from that country, although it may be a native here. It ranges northward from the Gulf to southern Virginia and Tennessee, and westward to Texas, growing most abundantly on low, black soils, which are well supplied with moisture. It is considered an excellent pasture grass, and when well established endures seasons of excessive drought without injury. It is particularly valuable as furnishing excellent late summer and autumn feed, during which period it makes its principal growth.

FIG. 70.—Knot-grass (*Paspalum distichum*).

No. 182. Paspalum distichum Linn. Knot-grass. (Fig. 70.)

A low creeping species, resembling Bermuda-grass. It is common in the Southern States along the seacoast and in the interior, extending southward from Virginia to the Gulf, and westward to Texas, Arizona, southern California, and northward to Oregon. It occurs throughout the tropical regions of both the Old and New Worlds. It grows in more or less sandy soils around the margins of ponds and along river banks. In such places it often does good service in binding soils subject to wash. The grass can well be recommended for this use. Its stems are somewhat succulent, extensively creeping, rooting at the nodes. The leaves are tender, affording excellent grazing. The upright stems are a few inches to a foot high, and bear at their summits two slender spikes. This character at once serves to distinguish it from Bermuda, which has several spikes at the apex of the flowering culms.

FIG. 71.—Smooth Paspalum (*Paspalum læve*).

No. 183. Paspalum læve Michx. Smooth Paspalum. (Fig. 71.)

A tufted native perennial, with ascending or erect stems, 1 to 3 feet long, flat leaves, and two to five, more or less spreading spikes, 2 to 4 inches long. Common in the Middle and Southern States, growing in open fields, meadows, etc., usually where the ground is somewhat moist. It is a late summer grass, blossoming from July to October. Well liked by all kinds of stock. In cultivated grounds, and particularly on lawns, which it occasionally invades, it must be classed as a weed.

No. 184. Paspalum scrobiculatum Linn. Ditch Millet.

A smooth annual, with branching, erect or ascending stems, 2 feet high or more. Widely distributed throughout the tropical and subtropical regions of both hemispheres. In northern India this grass is cultivated throughout the plains-region as a "rainy-season crop." It is usually sown on the poorer kinds of soil, the grain being chiefly consumed by the lower classes. The straw is used for fodder. (Duthie.) A variety of *P. scrobiculatum*, called "hureek" in India, which is perhaps the Ghohana-grass, an Indian species reputed poisonous, is said to render the milk of cows that graze upon it narcotic and drastic. (Lindley.)

No. 185. Pennisetum japonicum Trin.

Erect, with flattened simple stems, 1 to 2 feet high, very narrow leaves, and comparatively loosely flowered purplish or yellowish nodding panicles. A native of Japan. Occasionally cultivated as a curiosity or for ornament.

No. 186. Pennisetum latifolium Spreng.

A rather broad-leafed ornamental perennial, 3 to 5 feet high, branching above, with greenish rather dense panicles 1¼ to 2 inches long. Native of Uruguay and Argentina. In the latter country it is used for covering roofs of houses. Occasionally found cultivated here as an ornamental grass. It forms large tufts and is easily propagated by the roots or seeds. It may possess some value as a forage plant.

No. 187. Pennisetum macrourum Trin.

A South American species, with unbranched stems, 3 to 4 feet high, and densely flowered, cylindrical, yellowish panicles 6 to 8 inches long. Cultivated occasionally for its odd and ornamental appearance.

No. 188. Pennisetum spicatum. Pearl Millet.

An annual of luxuriant growth, 6 to 10 feet high, with long, broad leaves, stout culms, and terminal, erect, cylindrical, dense spikes 6 to 12 inches long, closely resembling those of the common cat-tail of the marshes. It is a native of the East, where it has been cultivated for its grain for many years. It is an important agricultural grass of Central Africa. It requires a rich loose soil to obtain the best growth, and under favorable conditions produces an enormous quantity of green fodder, for which purpose it can be cut several times during the season. It does not dry out readily and is often difficult to cure into hay. It has been cultivated with success as far North as Pennsylvania and in many parts of the South for a good many years. It is best sown in drills, about 2 feet apart, and 5 to 6 pounds of seed are required per acre. The weight of good seed per bushel is 56 pounds. The current price is $12 to $14 per 100 pounds.

No. 189. Pennisetum villosum Brown.

An Abyssinian species which has been introduced into cultivation because of its ornamental appearance. It grows to the height of 1 or 2 feet, has long narrow leaves, and dense, oblong or cylindrical, finely bearded heads 2 to 4 inches long. It is a hardy perennial, graceful and attractive in appearance, and is very frequently cultivated as an ornamental under the name of *Pennisetum longistylum*.

No. 190. Phalaris arundinacea Linn. Reed Canary-grass. (Pl. III, fig. 3.)

A tall, leafy perennial, 2 to 4 feet high, from a creeping rootstock, with smooth sheaths and narrow, branching panicles 4 to 8 inches long. It is a native, common on low, wet grounds, from New England southward to Tennessee, and extending across the continent to California and Washington. It is native also in Europe and northern Asia. It is little affected by either drought or cold, and thrives well in the shade. It succeeds best on stiff, wet land, and on wet, flooded fields and will grow fairly well upon rather dry, sandy soil. The rootstocks are very strong and creep extensively, making this grass particularly valuable for binding banks of rivers and ditches where the water supply is

ample. It does not attain its full size until the second year, and if designed for hay should be cut before flowering, for when fully mature the stems become woody and are too hard to make good fodder. The seed, which matures in July and August, is easily gathered. Good seed should have 95 per cent purity and 60 per cent germination. It may be propagated by seed or by cuttings of the rootstocks, these being laid down at intervals of 1 foot, and slightly covered. The retail price of seed quoted in the New York market is $35 per 100 pounds. A variety with white-striped leaves, called Ribbon-grass, is cultivated in gardens for ornament.

Fig. 72.—Canary-grass (*Phalaris canariensis*).

No. 191. Phalaris canariensis Linn. Canary-grass. (Fig. 72.)

An erect annual, 1 to 3 feet high, with flat leaves, and dense, ovoid panicles or heads about an inch long. This grass is apparently a native of the warmer countries of Europe, also of north Africa and western Asia. It has become widely distributed throughout the warmer temperate and tropical regions of the world, including Australia. Cultivated in Germany and southern Europe. It has been introduced into this country, and is occasionally cultivated for its seeds, which are used for bird food. The flour from the seeds is utilized in certain processes of cotton manufacture (weaver's glue), and is even employed in the making of some kinds of cake. It is frequently met with in waste grounds about dwellings in the vicinity of towns.

No. 192. Phalaris caroliniana Walt. Southern Canary-grass; Apache Timothy.

This and *Phalaris angusta* (Fig. 73) have usually been regarded as one species, the latter as a variety with more elongated heads and rather stouter growth. Both the species and variety are perennials, ranging from South Carolina to Florida and westward to Texas, Arizona, California, and northward on the Pacific slope to Oregon. *Phalaris angusta*, a stout grass, 2 to 5 feet high, is sometimes called Apache Timothy, owing to the resemblance of its heads to those of timothy. In California it is not esteemed as of any agricultural value, but in the Southern States it has been cultivated to a limited extent, and is spoken of by some a being an excellent grass for winter and spring grazing, as it remains green throughout the winter season.

Fig. 73.—Apache Timothy (*Phalaris angusta*).

No. 193. Phleum alpinum Linn. Mountain Timothy.

This grass is a native of the mountain regions from Maine to California and northward; also in northern Europe and Asia. It is closely related to cultivated timothy. The stems are usually stouter, more leafy, but not so tall, under most favorable conditions attaining a height of 2 feet, but rarely exceeding a foot.

No. 194. Phleum pratense Linn. Timothy. (Fig. 74.)

This is one of the best known and most extensively cultivated hay grasses. It is a native of Europe (where it is known as cat's-tail), north Africa, and northern and middle Asia, and has become thoroughly naturalized in North America. It

appears to have been first cultivated in this country, and it was from this country that the seeds were obtained for its cultivation in England about the year 1760. It has never attained the same high esteem in England that it holds here, where it is regarded as the standard of comparison for all other grasses grown for hay. It succeeds best on moist loams or clays. In very dry ground the yield is apt to be light. On such soils the base of the stem is often thickened and bulb-like. Timothy is usually sown in mixtures with other grasses and clovers. It may be used with red or alsike clovers, or with redtop. Good fresh seed should have an average purity of 97 per cent and a germinative power of 85 to 90 per cent, a bushel weighing 48 pounds. The amount required per acre varies with the quality of the seed, but of that containing 87 per cent pure in germinating, 16 pounds to the acre is sufficient. It is better, however, to sow half a bushel to the acre if sown alone. With red or alsike clovers about 10 per cent timothy is a proper mixture.

No. 195. Phragmites vulgaris (Lam.) B. S. P. Common Reed.

This is one of the largest of our native grasses, growing to the height of 12 feet, the rather stout culms bearing numerous broad, spreading, and sharply pointed leaves 1 to 2 feet long. It has deeply penetrating and extensively creeping rootstocks, making it one of the most valuable grasses for binding the banks of rivers subject to periodical floods. It is occasionally found along the coast in brackish marshes and sometimes upon sandy soils, and possibly may be employed with advantage for binding drifting sands or those liable to be shifted by high tides. The rootstocks are very strong, and when the grass is once established scarcely anything can remove it. The young shoots are liked by cattle and the mature stems make the best of thatch. It is very widely distributed throughout the temperate regions of both hemispheres, growing along river banks, borders of lakes, etc.

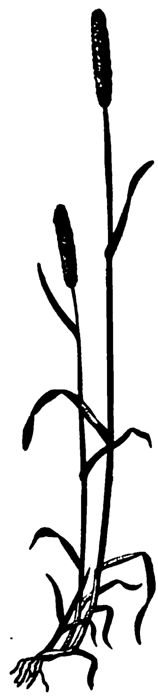


FIG. 74.—Timothy (*Phleum pratense*).

No. 196. Poa alsodes A. Gray. Wood Spear-grass.

A slender, erect perennial, 1 to 3 feet high, with flat leaves and a narrow, rather few-flowered panicle. It is a native, growing upon the wooded hillsides of New England, extending westward to Wisconsin, and southward through New York, Pennsylvania, and Virginia, to the mountain regions of North Carolina and Tennessee. It possesses no recognized agricultural value, but is apparently a good fodder grass, and may possibly prove of value in cultivation in woodland parks. Other closely related species of *Poa* extend westward across the continent.

No. 197. Poa annua Linn. Low Spear-grass.

A low, spreading annual, with erect or ascending somewhat flattened stems, 2 to 12 inches high. This is an introduced grass, common in every dooryard and about dwellings and cultivated grounds. It may be found in bloom in the Southern States in almost every month in the year. It often forms a considerable ingredient in poorly kept lawns, as a result of its spontaneous growth.

No. 198. Poa arachnifera Torr. Texas Blue-grass.

A strong-growing perennial, 1 to 3 feet high, with extensively creeping rootstocks, long leaves, and narrow, densely flowered panicles. This grass is apparently diœcious. The pistillate or seed-bearing plants have the spikelets densely woolly, while the male spikelets are smooth. It is a native of Texas, but is now well known in most of the Southern States, where it has been introduced into culti-

vation, having been highly recommended as a permanent pasture grass. It may be propagated by seeds or "root cuttings," which can be obtained from leading seedsmen. It makes its principal growth during the winter months, coming into bloom in the latter part of April or early in May. It makes a good sod and withstands well the heat of summer and protracted drought. Owing to the wooliness of the seeds, they are difficult to sow, and as they are rather expensive this grass has not been so extensively propagated as it otherwise would have been. A somewhat troublesome, but more certain, method of propagation is by root cuttings. These may be planted at any time during the fall or early spring months, being set out in rows 2 feet apart and 6 to 10 inches apart in the rows. The retail price of the seed, according to New York catalogues, is $3 per pound.

No. 199. Poa arida Vasey. Bunch Spear-grass.

A smooth, upright perennial, 1 to 2 feet high, with rather rigid, sharp-pointed leaves, and a close or narrow panicle 2 to 3 inches long. This grass is a native of the Rocky Mountain region, from the British Possessions southward to Arizona. It has short, creeping rootstocks, and although more rigid than many species of *Poa*, is one of the most valuable pasture grasses of the dry regions of the West.

No. 200. Poa buckleyana Nash. Bunch Red-top. (Fig. 75.)

Rather slender, 1 to 2 feet high, with no creeping rootstock, very narrow root leaves, and contracted panicles of usually purplish spikelets. It is a perennial, and a native of the Rocky Mountain regions, growing on the lower foothills and in the valleys. It grows in bunches, not forming a turf, and is regarded by the ranchmen as one of the most valuable "bunch grasses" of the cattle ranges. It has never been introduced into cultivation, but is deserving of attention, for it responds readily to improved conditions, and when growing along streams or in irrigated land makes a luxuriant growth of foliage, and often attains a height of 2 or 3 feet. There are many species of *Poa* native to the northern portion of our country, particularly in the Northwest, and all are tender, nutritious pasture grasses. Wherever grasses grow, from the seashore to the highest mountain tops, from one arctic zone to the other, the genus *Poa* has its representatives.

FIG. 75.—Bunch Red-top (*Poa buckleyana*).

No. 201. Poa compressa Linn. Canadian Blue-grass.

A slender perennial, with much-flattened stems, 6 to 20 inches high, and small, narrow panicles. This grass has extensively creeping rootstocks, and forms a strong turf. It is a native of Europe, which has become thoroughly naturalized, and is now very widely distributed over our territory. It is closely related to Kentucky Blue-grass, but it is more decidedly blue in color, and is readily distinguished from that species by its strongly flattened stems, lower habit of growth, and smaller panicle. It is the "Blue-grass" of the farmers of the New England and Middle States. It will grow upon a great variety of soils, even upon those so poor and thin as to exclude the growth of other grasses. In cultivated lands it is likely to become troublesome, owing to its creeping rootstocks. There is perhaps no better pasture grass for dry and poor soils, particularly in the Eastern and Middle States. It is especially valuable for dairy pastures; cows feeding on it yield the richest milk and finest butter. On good land it becomes sufficiently tall for hay, and as it shrinks very little in drying, the hay is heavy in proportion to its bulk. Seed is advertised by leading firms at $14 per 100 pounds.

No. 202. Poa fendleriana (Steud.) Vasey. Mutton-grass.

Widely distributed in the Rocky Mountain region and on the Pacific Slope, extending southward through Arizona into Mexico. It grows in tufts to the height of 1 to 2 feet, has numerous long root-leaves, and short, compact heads or panicles. It is tender, and affords a large amount of excellent grazing in the regions where it grows abundantly, and may prove a valuable acquisition to the forage grasses of the Atlantic States.

No. 203. Poa flabellata Hook. Tussock-grass.

A native of the Falkland and adjacent islands, which has attracted the attention of travellers by its stout habit of growth and evident nutritious qualities. The flowering stems are 5 to 8 feet high, and these are often exceeded by the numerous radical leaves. This grass grows in great tussocks, 1 to 4 or 5 feet across. The stems and long leaves are used for thatch. "It loves a rank, wet, peat bog, with the sea spray dashing over it, and wherever the waves beat with greatest vehemence and the saline spray is carried farthest, there the tussock grass thrives the best, provided, also, it is on the soil it prefers." It thrives in cold countries near the sea in pure sand at the edge of peat bogs. The base of the stem is edible, having a taste of mountain cabbage, a species of palm. The introduction of this grass to certain points along our Northern seaboard, where other grasses will not thrive or where there is danger of encroachment upon the land by the sea, may be desirable. The nutritious qualities of the grass and its furnishing good fodder the year round upon the Falkland Islands has been repeatedly noted by authors.

No. 204. Poa flava Linn. False Red-top.

A native of northern Europe and the northern portions of our own country, growing naturally in wet meadows and along the low banks of streams. It attains the height of 2 to 3 feet, or even 4 feet in rich, moist soils, and has an expanded, nodding panicle of rather small, purplish, or "bronzed" spikelets. It is found in nearly all parts of New England, and often forms a very considerable and valued portion of the native hay of the low meadows. It has been cultivated to some extent, but should only be used in mixtures, as it does not make a good sod when sown alone. It blooms in July and August.

No. 205. Poa nemoralis Linn. Wood Meadow-grass.

The larger forms of this are hardly to be distinguished from *Poa flava*, and have a similar range. It will, however, grow in a drier soil, excessive moisture being harmful to it. In Montana this species ascends to the altitude of 9,000 feet. At this elevation it is dwarfed in habit, but at lower elevations it becomes taller and affords excellent forage. There are several varieties of this grass in the Rocky Mountains and the Northwest, some of them growing upon the dry foothills and bench lands. The larger forms are well adapted for hay. It is less productive than many others, and its cultivation is not recommended, excepting in shady parks or open woodlands where an increase of forage is desired, or in shaded lawns, and then only in the Northern and Middle States.

No. 206. Poa nevadensis Vasey. Nevada Blue-grass.

A perennial bunch grass from the western prairie and plains regions. It grows on both dry and damp soils, produces a large amount of excellent hay, and is apparently worthy of cultivation.

No. 207. Poa pratensis Linn. Kentucky Blue-grass. (Fig. 76.)

This is apparently native throughout the temperate regions of the northern hemisphere. It ranges from Labrador to South Carolina, westward to the Pacific coast and northward to Alaska. In the limestone regions of Kentucky and Tennessee it attains its greatest perfection and is there regarded as the king of

pasture grasses. It requires a good soil containing some lime in order to yield profitable crops. It is largely employed in the Eastern and Middle States as a lawn grass, for which use it is well adapted. It makes a good, firm sod, and is particularly well suited for turfing the slopes of terraces and embankments, where the soil is good. There are several varieties, which differ chiefly in the breadth and length of the leaves, particularly those at the base of the stem. It is not so well adapted for the production of hay as it is for pasturage. It should enter into all mixtures designed for permanent pasture. The slender stems of this grass afford an excellent material for the manufacture of the finer kinds of Leghorn hats. Good and well-cleaned seed should have 95 per cent purity and 50 per cent germinating power. The power of germination, however, is usually much below this figure. When used for lawns, sow at the rate of 3 bushels per acre. According to Stebler and Schroeter, the seeds should never be covered, but only rolled after sowing, because they germinate better in the light than in darkness. This is the June-grass of the Northern States, Green-grass of Pennsylvania, and Smooth-stalked Meadow-grass of England.

FIG. 76. Kentucky Blue-grass (*Poa pratensis*).

No. 208. Poa subaristata Vasey. Vasey's Spear-grass.

A perennial, from central Montana, where it is common on dry hills and mountain slopes, forming a large percentage of the grass and supplying good pasturage. It is an excellent species for cultivation in Northern pastures.

No. 209. Poa trivialis Linn. Rough-stalked Meadow-grass.

An erect perennial, 1 to 3 feet high, with an open, spreading panicle, closely related to Kentucky Blue-grass, from which it differs in having no conspicuous rootstock and the stem distinctly rough below the panicle. It has been cultivated for many years in England, and is now highly esteemed as an ingredient in mixtures for permanent pastures. It succeeds best where the climate and soil are rather moist and cool, but is not adapted to sandy soil. In northern Italy this grass is known as the "queen of forage plants," but elsewhere, particularly in this country, it is not so highly esteemed, its principal use being to form bottom grass in permanent pastures. Seed of good quality should have 95 per cent purity and 50 per cent germination. When sown alone 1½ to 2 bushels of seed are required per acre.

No. 210. Poa wheeleri Vasey. Wheeler's Blue-grass.

A perennial native pasture grass that grows on the high plains and on the mountain slopes, below timber line, from Colorado northward. It is one of the best grazing grasses of the Rocky Mountains and promises to do well in cultivation.

No. 211. Pollinia fulva Benth. Sugar-grass.

A slender or rather stout perennial, 1 to 4 feet high, with narrow leaves and two to three terminal spikes, which are clothed with brown, silky hairs. It is a

native of Australia, found throughout all the colonies of that country, growing chiefly on the richest soils and on deep alluvial flats bordering rivers and creeks. It is productive, and much prized by cattlemen. The name "sugar-grass" is applied to this species on account of the sweetness of its stems and foliage. Mr. Fred Turner recommends it for cultivation on good land, especially in grazing districts, and he speaks of it as being a good grass to plant on the banks of rivers, creeks, and dams, as its strong, penetrating roots would help to bind the soil and prevent its being washed away by heavy rains or floods. This grass is classed as a variety of *Pollinia cummingii* Nees, by Hackel.

No. 212. Puccinellia maritima (Huds.) Parl. Sea Spear-grass.

A slender grass, 12 to 18 inches high, with creeping rhizomes. It occurs in the marshes along the seacoasts of New England and the Middle States, and forms a valuable element of the hay of tide-water marshes.

No. 213. Redfieldia flexuosa (Thurb.) Vasey. Redfield's-grass. (Fig. 77.)

A stout, native perennial, 18 inches to 4 feet high, with long, narrow leaves and diffusely spreading panicles, growing in the sandy districts of Nebraska, Colorado, and Kansas. It has deeply penetrating and widely spreading underground stems or rhizomes, making it a valuable species for binding drifting sands. It is a characteristic grass of the sand hills of central Nebraska, growing in the drifting sands and "blow-outs," and is a conspicuous and almost the only grass found on the sand dunes south of the Arkansas River, near Garden City, Kans.

FIG. 77.—Redfield's-grass (*Redfieldia flexuosa*).

No. 214. Saccharum ciliare Anderss.

A tall, handsome grass of India, with smooth stems, 8 to 10 feet high, long leaves, and large, showy panicles of silky-hairy flowers. Used in the manufacture of matting, rope, and paper, and for thatching. The stems are made into sieves, screens, and baskets. The thicker portion of the stems is used for lining wells, and in making chairs and couches. The leaves are sometimes used for fodder, and when young the grass is grazed by cattle.

No. 215. Saccharum officinarum L. Sugar Cane.

A stout grass with many-jointed stems, 8 to 15 feet high, broad leaves, 3 to 4 feet long, and long (16 to 32 inches), pyramidal panicles. Native country unknown, but sparingly spontaneous in the South Sea Islands, where it blossoms freely. Cultivated in all tropical countries. Propagated chiefly by cuttings of the stems. There are many varieties, distinguished chiefly by the color and height of stem. The leaves are sometimes used for fodder, and, to a limited extent, also in paper making. The cane is cultivated, however, for its sweet juice, which yields from 12 to 20 per cent sugar. Under favorable circumstances an acre of ground will produce about 20 tons of cane. In this country the production of cane sugar on a commercial scale is practically limited to the States of Loui-

siana and Texas. The sugar production in Louisiana in 1889 was 292,124,050 pounds. The world's production of cane sugar was then about 3,000,000 tons, more than one-third of which was produced by the West Indies. Molasses is a product of sugar cane (the uncrystallizable sugar), and rum is made from molasses. Refuse cane, from which the juice has been expressed, yields a strong fiber, and in parts of India is used for torches, etc.

No. 216. Savastana odorata (Linn.) Scribn. Vanilla-grass. (Fig. 78.)

A rather slender, sweet-scented perennial, 1 to 2 feet high, with short culm leaves and brownish panicles. Moist meadows and mountains of the Northeastern States, extending westward to Oregon. This grass, remarkable for its fragrance, has long, creeping rhizomes, from which spring the flowering culms and numerous

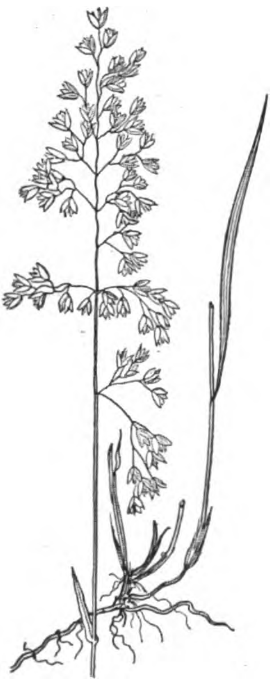


FIG. 78. — Vanilla-grass (*Savastana odorata*).

FIG. 79. — Cord-grass (*Spartina cynosuroides*).

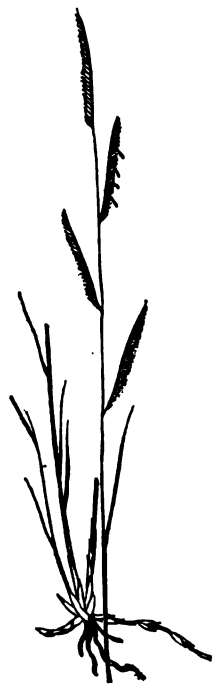


FIG. 80. — Fox-grass (*Spartina patens*).

long-leafed sterile or flowerless shoots. These long leaves are woven into small mats and boxes by the Indians, and find a ready market because of the sweet odor, which they retain for a long time. This odor resembles that of sweet vernal grass, but is more powerful, especially when this grass is dry. In some European countries it is believed to have a tendency to induce sleep, and bunches of it are hung over beds for this purpose. It makes a good turf, but is of little value for forage. In the Northwest Vanilla-grass is generally called Sweet-grass.

No. 217. Secale cereale Linn. Rye.

An annual, 4 to 6 feet high, with flat leaves and a terminal, somewhat flattened, bearded spike 4 to 6 inches long. The rye crop of the United States in 1895 was 27,210,070 bushels, nearly half of which was produced in the States of

Pennsylvania, New York, and Wisconsin. Rye is more largely cultivated in central and northern Europe than in America; the grain is there very largely used for making bread. It is comparatively little used in this country for that purpose, being chiefly employed in the manufacture of malt and spirituous liquors. The straw, which is longer than that of other grains, and more uniform in size throughout, is employed in the making of a great variety of articles, such as paper, hats, bonnets, mats, slippers, toys, and fancy articles. Rye straw is little valued for fodder, but when green it is esteemed as a forage plant, and is sometimes sown for this purpose in the Southern States, cattle being allowed to graze on it during the fall and winter months. For winter grazing it should be sown upon well-prepared land early in August, when it will be ready to pasture or to cut green in the latter part of October, and may be grazed throughout the winter months.

No. 218. Spartina cynosuroides (Linn.) Willd. Cord-grass. (Fig. 79.)

Stout, with erect, simple stems 2 to 9 feet high, flat and long-pointed leaves, and numerous erect or spreading spikes 2 to 5 inches long. This is a native, common along our ocean and lake shores, borders of rivers, etc., ranging from Maine to the Carolinas, and westward to the Pacific. It makes a fair but rather coarse hay when cut early, and has been successfully employed in the manufacture of twine and paper. The strong, creeping, scaly rootstocks of this grass adapt it for binding loose sands and river banks, and in the West it is used for thatch.

No. 219. Spartina patens (Ait.) Muhl. Fox-grass. (Fig. 80.)

A rather slender species, 1 to 2 (rarely 3 to 4) feet high, with two to four slender, erect, or widely spreading spikes. This is common upon the salt marshes, and is one of the most valued species which go to form the salt hay that these marshes produce. It ranges from Maine southward to Florida and along the Gulf coast to Texas. It is useful for packing glassware, crockery, etc., and in the larger towns along the coast is much used for this purpose. Fox-grass and Black-grass (*Juncus gerardi*) are regarded as the best of the grasses of the salt marshes for the production of hay, and chemical analyses have proved the correctness of this opinion. Salt hay, composed chiefly of these grasses, at average market prices is decidedly cheaper than timothy hay.

FIG. 81.—Creek-sedge (*Spartina stricta maritima*)

No. 220. Spartina stricta maritima (Walt.) Scribn. Creek-sedge. (Fig. 81.)

An erect and often stout salt marsh grass, with flat leaves, and few to many erect spikes. It varies a good deal in size, the larger form attaining a height of 5 to 8 feet. It grows along the ditches and creeks of the marshes, and is conspicuous by its size and long, shining leaves, which are of a deep green color. Smaller forms are found over the marshes away from the ditches, and these often are of a pale-green tint, with comparatively short and shining leaves. All the forms are somewhat succulent and have a rank odor, which is imparted to the milk and butter of cows feeding upon them. The species is of little value for fodder, but makes excellent thatch, and is used to some extent for litter and mulching. This is a characteristic grass of the salt marshes, and is found along both the Atlantic and Pacific coasts of our country and on the shores of Europe.

No. 221. Spinifex hirsutus Labill. Spiny Rolling-grass. (Fig. 82.)

A sand binder of the coasts of Australia, New Zealand, and Tasmania. It has stout,

creeping stems, rooting at the joints, and sending up coarse, leafy tufts. The whole plant is clothed with soft hairs. The male and female flowers are borne on separate plants, the latter in globular heads, which fall off at maturity and are driven over the sands by the winds, dropping their seeds as they roll along, or are carried about by the waves and deposited on newly formed sand bars, there to continue the embanking process. It has no value for forage, but in New South Wales is regarded a most useful grass for fixing drift sands when encroaching upon valuable lands. It is readily propagated by cuttings or joints of the stems, is of comparatively quick growth, and is very persistent when once established. It would doubtless be of some value on our own Southern and Californian coasts as a sand binder.

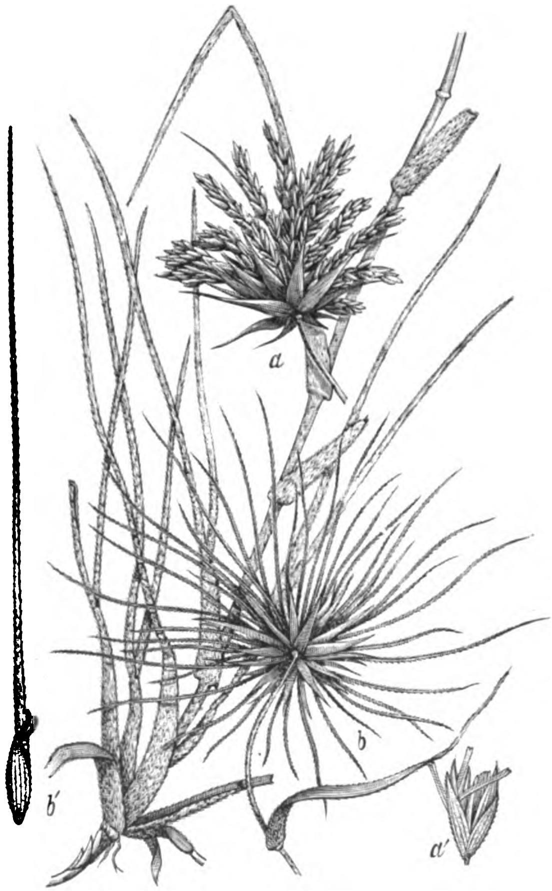


FIG. 82.—Spiny Rolling-grass (*Spinifex hirsutus*): *a*, male inflorescence; *b*, female inflorescence; *a′*, male spikelet; *b′*, female spikelet.

No. 222. Sporobolus airoides Torr. Alkali Saccaton. (Fig. 83.)

A stout rather coarse and rigid grass, growing on tussocks in sandy and more or less alkaline or saline soils along rivers and streams, ranging from Montana southward to Texas and westward to California. It has a widely spreading panicle, more open than saccaton, and the grass rarely exceeds 2 feet in height. In some places in Nevada, Utah, and New Mexico it occurs abundantly, and yields a coarse fodder, which is eaten by stock when more tender grasses are not available.

No. 223. Sporobolus asperifolius (Nees and Mey.) Thurb. Fine-top Salt-grass.

A low, somewhat creeping grass, 6 to 15 inches high, with numerous short, spreading, acute leaves, and an expanded capillary panicle 3 to 5 inches long. It grows on alkaline plains from Texas northwest to British Columbia, in similar situations as *Distichlis spicata*, and like that species often forms a dense, continuous turf. It grows well on strongly alkaline soil, and may prove valuable for propagation on such lands.

No. 224. Sporobolus cryptandrus (Torr.) A. Gray. Dropseed.

A strongly rooted perennial, 2 to 3 feet high, with usually narrow, rather densely flowered panicles, which are generally partially inclosed within the upper leaf-

sheath. Common on the Western plains and in the Rocky Mountain region. It is a tender species, apparently well liked by stock, and where it occurs abundantly is very generally regarded as an important forage plant. In northern central Kansas it is spoken of as one of the best early grasses, and the same is said of it in Young County, Texas.

No. 225. Sporobolus indicus (Linn.) R. Br. Smut-grass. (Fig. 84.)

A tufted, wiry, erect perennial, 1 to 3 feet high, with narrow, densely flowered, spike-like panicles 4 to 12 inches long. This grass is widely distributed throughout the warmer temperate regions of the world, and has become quite common in many parts of the Southern States, growing in scattered tufts or patches about dwellings and in dry, open fields. As the season advances, the long, slender panicles often become overgrown by fungus, so that they appear as if

FIG. 83.—Alkali Saccaton (*Sporobolus airoides*).

FIG. 84.—Smut-grass (*Sporobolus indicus*).

attacked by smut; hence the common name "Smut-grass." By some it is looked upon as valuable for forage, but the stems soon become too tough and wiry to be readily eaten by stock, and in fields where this grass occurs it is usually avoided by cattle when other food can be had.

No. 226. Sporobolus junceus (Michx.) Kunth. Rush-grass.

Common in the dry, pine-barren regions of the Southeastern States. It grows to the height of 18 inches to 2 feet, and is of little or no agricultural value. This and *Aristida stricta* are known throughout the South as "Wire-grass."

No. 227. Sporobolus orientalis Kth. Usar-grass.

A wiry, creeping perennial, with rather short, rigid leaves and diffuse panicles. It is a native of India, growing upon saline soils, often constituting the entire vegetation of the extensive "usar" tracts of northern India. A valuable grass for

alkaline or saline soils, yielding a liberal supply of fodder where other plants are unable to exist.

No. 228. Sporobolus wrightii Munro. Saccaton. (Fig. 85.)

A stout, erect perennial, 4 to 8 feet high, with long, narrow leaves and a slightly spreading panicle 12 to 36 inches long. It grows in great clumps, producing a large quantity of coarse, tough stems and leaves, which, however, in the regions where this grass is native—Arizona and New Mexico—yield a hay which is valued for horses and mules. As a hardy perennial for saline bottoms subject to flooding or incapable of cultivation, this species deserves notice. The Indians and Mexicans of Arizona and Lower California call all hay grasses "zacate," without any distinction between the species.

Fig. 85.—Saccaton (*Sporobolus wrightii*).

No. 229. Stenotaphrum dimidiatum (Linn.) Brongn. St. Augustine-grass. (Fig. 86.)

This grass has a wide distribution, being found in the tropical and warmer temperate regions of both the Old and New World. In New South Wales it is known as Buffalo-grass, and in Jamaica it is called Pimento-grass. It grows upon every variety of soil, from the apparently sterile sand dunes to heavy clays, but is rarely found far away from the coast. The flattened stems emit fibrous roots at every joint, where they also readily separate, each piece becoming a new center of growth. The leaves are flat or simply folded, blunt or obtuse at the apex, nearly one-fourth of an inch broad and 4 to 10 inches long. The flowering stems grow to the height of 6 inches to a foot or more. St. Augustine-grass grows along our ocean shores as far north as South Carolina, and is extensively used for lawns in Charleston, S. C., and cities in the South near the coast. It is useful for holding sloping embankments, especially those subject to wash. It is propagated by cuttings or sets, and quickly covers the most sandy yards with a dense, carpet-like growth. In South America the creeping stems are employed in medicine as a diuretic. This is the Buffalo-grass of Australia, and other local names in this country are Mission-grass and Charleston Lawn-grass.

No. 230. Stipa comata Trin. & Rupr. Needle-and-Thread.

This is one of the bunch grasses common in the Rocky Mountain region, growing on the dry mesas and foothills. It is a rather stout, leafy perennial, 1 to 3 feet high, with a panicle usually partly inclosed in the upper leaf sheath; the slender awns of the spikelets are 4 to 6 inches long and flexuose. This grass has some value, affording forage of good quality in the regions where it grows abundantly. In Dakota, Wyoming, etc., it is valued as a hay grass.

No. 231. Stipa elegantissima Labill.

A native of Australia, with erect, branching stems 2 to 3 feet high, narrow leaves, and loose panicles 6 to 8 inches long. The axis and long, thread-like branches of the panicle are elegantly plumose with fine, spreading hairs, rendering it highly ornamental. Cultivated in gardens.

No. 232. Stipa leucotricha Trin. & Rupr. **Bearded Mesquite.**

An erect perennial, 1 to 3 feet high, with very narrow leaves and a loose panicle with a few long-awned spikelets. One of the best native hay grasses of central and southern Texas.

No. 233. Stipa pennata Linn. Feather-grass.

A native of southern Europe, 1 to 2 feet high, growing in dry, open ground, and often cultivated in gardens as an ornamental, the very long, slender awns being clothed with spreading, silky hairs, presenting a very graceful plume-like appearance. A variety of this grass (*Stipa pennata neo-mexicana*) grows wild in the mountain regions of western Texas and Arizona. It is an elegant form of the species, growing in clumps 6 to 12 inches in diameter, and is deserving the attention of the florist.

No. 234. Stipa setigera Presl. Bear-grass.

A native of California, extending northward to Oregon and eastward through New Mexico and Arizona to Texas. It is common on the coast ranges and on the foothills of the Sierra Nevada, where it is regarded as one of the most valuable of the native bunch grasses.

No. 235. Stipa spartea Trin. Porcupine-grass.

Rather stout, 18 inches to 3 feet high, with long leaves and few-flowered panicles. The stout and twisted awns are 3 to 6 inches long, and at the base of the flowering glume is a long and very sharp-pointed callus. When mature, the awned flowering glumes soon fall off, leaving the large, pale, straw-colored, persistent empty glumes, which impart to the panicle a characteristic oat-like appearance. The awns, when dry, are bent and very strongly twisted, but when moistened they gradually untwist, a character which enables the seeds to bury themselves in the ground, this being possible on account of the very sharp callus at the base of the fruiting glume. The same character also renders the seeds of this grass dangerous to sheep, as they readily become attached to the wool, and may penetrate the flesh of the animal, causing serious injury. Aside from this danger of affecting the quality of the wool, and possibly the life of the sheep, this grass may be considered a good forage plant, as it makes a very good hay, although somewhat coarse. It is particularly common in the prairie regions of Iowa, Nebraska,. South Dakota, and Minnesota, extending westward to the Rocky Mountains, where it frequently occurs upon the dry foothills and bench lands. This is the Buffalo-grass of the Saskatchewan region. In some localities it is known as Needle-grass, but that name is reserved for *Aristida fasciculata*. It is also known as "wild oats" in North Dakota.

FIG. 86.—St. Augustine-grass (*Stenotaphrum dimidiatum*).

No. 236. Stipa tenacissima Linn. Esparto.

A native of the sandy regions of southwestern Europe and northern Africa. It is a tall perennial, with long, stiff, and very tough leaves, from which ropes, baskets, mats, hats, and other articles are woven. The leaves are employed largely in England and this country in the manufacture of paper, for which purpose this grass is superior to straw. It is one of the most important articles of export from Algeria, and from northern Africa and Spain more than 2,000 tons of Esparto are exported to Great Britain annually. "Ten tons of dry Esparto, worth from $18 to $25 per ton, can be obtained from an acre under favorable circumstances."

The grass will grow on almost any kind of soil, from that which is poor and sandy or gravelly to heavy calcareous and clayey soils. It thrives in the dry and hot climates of northern Africa, where many millions of acres are covered almost exclusively with it. This grass is extensively cultivated in the south of France, and possibly its introduction into some of our Southwestern districts may render profitable, regions now practically worthless. It may be propagated by seeds or by divisions of the root. The latter is the more common method. This and *Lygeum spartum* constitute the Esparto of commerce.

No. 237. Stipa vaseyi Scribn. Sleepy-grass.

A stout bunch-grass 3 to 5 feet high, which grows in the Rocky Mountains at an altitude of from 5,000 to 6,000 feet. This grass, although producing a large bulk of stems and leaves, is regarded with suspicion by stockmen. It is said that when this grass is eaten in a fresh state by horses it has a narcotic or poisonous effect, causing the animals to become crazed or "locoed," its action thus resembling that of the deadly loco weed (*Astragalus mollissimus*). Hay made from this grass does not apparently possess any poisonous qualities.

FIG. 87.—Feather Bunch-grass (*Stipa viridula*).

No. 238. Stipa viridula Trin. Feather Bunch-grass. (Fig. 87.)

A rather slender grass, 1 to 3 feet high, growing in the Rocky Mountain region and on the foothills and mesas, from British Columbia southward to Mexico and westward to the coast On good land, under irrigation, this grass attains the height of 3 feet or more, and is by far the most valuable of the Stipas for hay. The leafy culms are terminated by a narrow, many-flowered panicle of comparatively small and rather short-awned spikelets. The seed may be easily gathered. The callus at the base of the fruiting glume is short and barely pointed and not produced into a long, very sharp, spur-like extension, as in Porcupine-grass.

No. 239. Thuarea sarmentosa Pers.

A low, extensively creeping grass, rooting at the joints, with ascending flowering branches, short leaves, and slender spikes about an inch long. A native of Ceylon, northern Australia, etc., growing on the sands of the coast. It is a tender grass, and may be useful in binding coast sands in tropical countries or in the formation of lawns.

No. 240. Trichloris blanchardiana Scribn.

A perennial, $1\frac{1}{2}$ to 3 feet high, with flat leaves, and six to eighteen slender, bearded spikes, which are 2 to 5 inches long, digitate or fasciculate at the apex of the culm. It has long been known to florists under the name of *Chloropsis blanchardiana*, and is esteemed as an ornamental grass, its attractive appearance making it worthy of attention. It grows in Arizona and Mexico, extending into South America.

No. 241. Tricholæna rosea Nees.

A South African annual (?), with diffusely branching stems 2 to 4 feet high. The spikelets are in loose panicles, and clothed with reddish, silky hairs. It pre-

sents a pleasing appearance when in flower, and the panicles are valued for dry bouquets. It has recently received some attention by agriculturists on account of its very vigorous rapid growth and productiveness. Experiments made in this country and elsewhere indicate that it possesses much value as a meadow or hay grass in mild climates. Three hundred stems have been counted on a single plant. These stems take root wherever they touch the ground, and an acre has been calculated to yield 30 tons of green fodder in the rich valleys of the Macleay River, New South Wales. It is easily propagated by seed.

No. 242. Triodia exigua Kirk.

A little alpine grass, endemic in New Zealand. It forms even plots of turf, often many square yards in extent; the leaves are firm, short, and shining; the compact growth of the turf or sward prevents the encroachment of other grasses or weeds. It is particularly to be recommended for croquet lawns, never requiring mowing (Kirk). In the mountain regions of the West are several of these small turf-forming grasses, which would, if cultivated, make excellent carpet-like lawns in the region of the Northern and Middle States.

No. 243. Triodia seslerioides (Michx.) Benth. Fall Redtop.

A stout, erect, native perennial, 3 to 5 feet high, with long, flat leaves and an ample, spreading, usually purple panicle 6 to 12 inches long, growing in dry or sandy fields from southern New York southward and westward to Missouri, blooming in August and September. It is a striking grass, and often covers considerable areas, but is apparently not liked by stock, and is not recognized as possessing any agricultural value.

No. 244. Tripsacum dactyloides Linn. Gama-grass. (Fig. 88.)

A tall, coarse perennial, 3 to 8 feet high, growing in large tufts, and producing a great mass of broad leaves, which when young and succulent are eaten with avidity by all kinds of stock. When abundant it affords a large amount of natural forage, and is valuable to this extent. It has very strong, creeping rootstocks, and the quantity of forage produced is large and of excellent quality. The grass may be deserving of cultivation for forage under certain conditions, and it makes an interesting and attractive plant for lawn decoration or the garden. A rich and rather moist soil is best suited to it.

Fig. 88.—Gama-grass (*Tripsacum dactyloides*).

No. 245. Trisetum pratense Pers. Yellow Oat-grass.

A rather slender, loosely tufted perennial, growing to the height of 2 feet. It is a native of Europe, northern Africa, and western Asia. It occurs along roadsides, in open fields, and on grassy mountain slopes, where its presence is said to indicate land of good quality. In Europe, Yellow Oat-grass is classed with the best fodder plants and is highly valued for temporary, but more particularly for permanent pastures. It can be grown on almost every variety of soil, is fairly productive, and is readily eaten by stock. This grass has a record of yielding on clayey loam soils 8,167 pounds green grass, 2,858 of hay, and 1,083 of aftermath per acre. In this country it has received little attention. It is quoted in New York seed catalogues, the price ranging from $70 to $115 per 100 pounds. Sown only in mixtures.

No. 246. Triticum æstivum Linn. Wheat.

Wheat in its many varieties is one of the most important of the true grasses. It is one of the oldest of the cultivated cereals, the grains having been found in very ancient Egyptian monuments, dating back to 2,500 or 3,000 B. C. The numerous varieties are distinguished by the firmness of the axis of the spike (continuous), or its brittleness (articulated); by the presence or absence of awns or beard; by the color of the chaff, and color and size of the grain. *Triticum æstivum speltum*, of which there are a number of subvarieties, is one of the oldest grains, and was everywhere cultivated throughout the Roman Empire, forming the chief grain of Egypt and Greece. It is still grown to some extent in parts of Europe, notably in northern Spain and southern Germany. In 1895 the wheat crop of the United States was placed at 467,102,947 bushels, while the wheat crop of the world is estimated at 2,400,000,000 bushels. For a discussion of the classification of the varieties of wheat, see Hackel's True Grasses (English translation), and the Fourth Annual Report of the New York Agricultural Experiment Station, 1885.

FIG. 89.—Broad-leafed Spike-grass (*Uniola latifolia*).

No. 247. Triticum polonicum Linn. Wild-goose Wheat.

A very striking species or variety of wheat, with large, compressed, and usually bluish-green spikes or heads. The native country of this *Triticum* is not known, but it probably originated in Spain, where it is now cultivated to a considerable extent. It is also cultivated more or less in Italy and Abyssinia. The long and slender fruit resembles rye, but is on the whole larger. It has sometimes been advertised by seed dealers and sold to farmers under the name of Giant Rye. It is inferior to many other varieties, for, although the heads present a fine appearance, the production of kernels is small; consequently the yield of grain is light.

No. 248. Uniola latifolia Michx. Broad-leafed Spike-grass. (Fig. 89.)

Erect, with rather stout, leafy stems 2 to 4 feet high, and drooping panicles of large, flat spikelets. The leaves are broad and widely spreading, and these, together with the graceful, nodding, open panicles, render it pleasing in appearance and worthy of cultivation for ornament. It has very strong, creeping roots, and is found chiefly along streams and thicket borders from Pennsylvania southward and westward to Illinois. A grass of little or no agricultural value.

No. 249. Uniola paniculata Linn. Seaside Oats.

A native, with stout, erect stems 3 to 5 feet high, long, rigid leaves, and showy nodding panicles of broad, pale straw-colored spikelets. The panicles are gathered for dry bouquets, and are often seen in our markets, along with the plumes of Pampas-grass. It grows in the drifting sands along the seashore, just above high tide, from Virginia southward to Florida, and along the Gulf Coast westward to Texas. It is an excellent sand binder, its rootstocks being very strong and penetrating deeply into the soil, much like those of Beach or Marram grass,

of which it is a southern analogue. The leaves are sometimes cropped by cattle, but the grass is too tough and dry to be of any importance as a forage plant. *Uniola condensata* of similar habit of growth, but with more densely flowered panicles, is found in the sands along the coast of Lower California.

No. 250. Zea mays Linn. Indian Corn or Maize.

One of the most valued of the cultivated cereals. The many varieties which have originated in cultivation have been variously classified. They differ much in size, in the form, size, color, and hardiness of the grain, and in the time required for ripening. Husk Maize, in which the kernels are separately enveloped in broad, herbaceous glumes, may approach the native form, which doubtless had its origin in tropical America. *Mais de coyote,* regarded by some as a distinct species, is said to grow wild in some parts of Mexico. The stems of this variety are branched above, and the numerous small ears are borne in the upper leaf axils all along the branches. The kernels are rounded and depressed, or conical with a rather acute apex pointing forward in two opposite rows, or irregularly arranged in four to six rows. Aside from its great value as a cereal, ordinary field corn is the best of the annual forage plants for soiling, and is also valued and used by many farmers for ensilage, being cut for this purpose when the kernels commence to glaze. Among the many uses of corn may be mentioned that of making cakes and corn bread, mush or hasty pudding, which is boiled corn meal, a very common dish in New England; mixed with rye and wheat flour the corn meal is used in making "brown bread"; green corn, boiled or roasted, is very largely eaten in its season, and canned corn is an important article of food; pickled green corn also is a favorite dish with many; hulled corn, or hominy, prepared by soaking the ripe grain in lye for a certain length of time and then removing the hulls or covering of the kernels, is a favorite dish in New England; popped corn, obtained by shaking the shelled corn of certain varieties in a suitable dish over live coals or a hot stove, is a luxury with children, and mixed with sugar or sirup is made into corn balls and various kinds of candy; corn and corn meal are largely fed to farm stock in this country, particularly to cattle and hogs; alcoholic liquors in immense quantities are distilled from the grain; corn husks (the leaves covering the ears) are used in making paper, in upholstery, and for filling mattresses. The total corn crop of the United States for the year 1895 was 2,151,138,580 bushels, valued at $544,985,534. The largest crop of any one State for that year was produced by Iowa, and amounted to 298,502,650 bushels.

Fig. 90.—Wild Rice (*Zizania aquatica*).

No. 251. Zizania aquatica Linn. Wild Rice. (Fig. 90.)

A tall, erect annual, 3 to 10 feet high, growing in shallow water along rivers and lakes from Canada southward to Florida and westward to Texas. The grain is a favorite food of the reed bird, and the grass is cultivated to some extent by sportsmen with a view to attracting these and aquatic fowl. It grows very rapidly in 1 to 8 feet of water, and matures its seeds in August or early in September. It succeeds best when sown in the fall broadcast in 2 or 3 feet of water

having a muddy bottom, but it can be sown in the spring in water from 6 inches to 5 feet deep. Before sowing soak the seeds in water twenty-four hours. Current retail price of the seeds is 25 cents per pound. This grass is abundant in the tide waters of the rivers of the Middle States, notably in the Delaware below Philadelphia, where it is always designated as "the reeds." The stems are used by coopers for making the joints of barrels intended to hold whisky or petroleum perfectly tight. This grass is the *Manorrin* of the Chippewa Indians, who gather the grain for food.

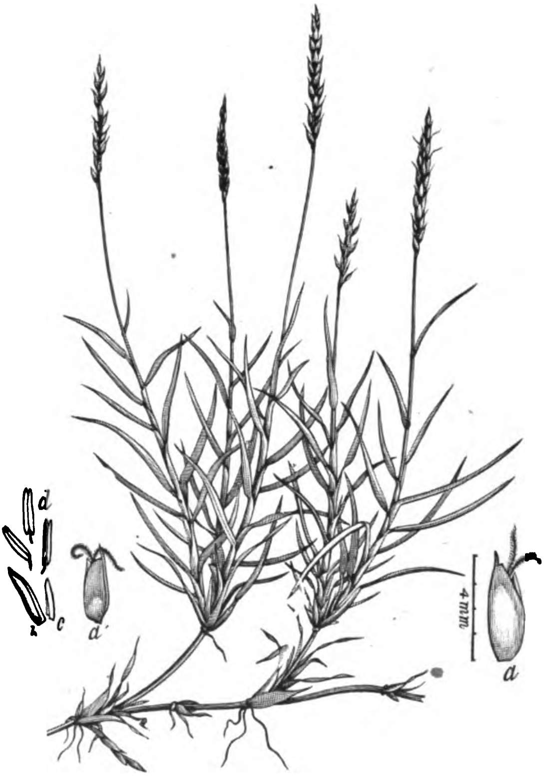


FIG. 91.—Japanese Lawn-grass (*Zoysia pungens*); *a* to *d* details of the spikelet.

No. 252. Zoysia pungens Willd. Japanese Lawn-grass. (Fig. 91.)

A creeping maritime grass growing on the sandy shores of tropical and eastern Asia, Australia, and New Zealand. In Australia it is considered an excellent sand-binder, and, while valuable for this purpose, it is at the same time an excellent forage plant. Under favorable circumstances it forms a compact turf and affords a large amount of choice pasturage. Constant cropping appears to improve it and increase the density of the turf. In the foreign settlements of China and Japan it is prized as a lawn grass, especially for tennis courts. It is finer-leafed than St. Augustine-grass, and may prove superior to that for lawns in the Southern and Gulf States. The habit of growth of Japanese lawn-grass is very similar to that of Bermuda, but the creeping stems are rather stouter and more rigid and the upright branches or tufts of flowering stems are never so tall, rarely exceeding 6 inches. It may be propagated by root cuttings or by seed. Importations of both roots and seeds from Korea have been successfully grown here, and the grass has proved hardy as far north as Connecticut. The leaves turn brown in the autumn, as do those of Bermuda.

GRASSES FOR SPECIAL SOILS OR USES.

The following lists include the best known and most valuable of the economic grasses. Descriptions of the species enumerated will be found in the body of the work. Seeds or roots of nearly all can be obtained from seedsmen.

HAY GRASSES.

Agropyron tenerum, Agrostis alba, A. vulgaris, Alopecurus pratensis, Andropogon halepensis, A. provincialis, Arrhenatherum elatius, Astrebla pectinata, Avena sativa, Bouteloua curtipendula, Brachypodium japonicum, Bromus inermis, Chætochloa italica, Cynodon dactylon, Cynosurus cristatus, Dactylis glomerata, Eragrostis abyssinica, Euchlæna luxurians, Festuca elatior, Hordeum sativum, Lolium italicum, L. perenne, Oryza sativa, Panicum crus-galli, P. maximum, P. miliaceum, P. molle, P. sanguinale, P. texanum, Pennisetum spicatum, Phalaris arundinacea, Phleum pratense, Poa pratensis, Saccharum officinarum, Tricholæna rosea, Trisetum pratense, Triticum æstivum, Zea mays.

PASTURE GRASSES.

Agropyron divergens, Agrostis alba, A. stolonifera, A. vulgaris, Andropogon nutans, A. provincialis, A. scoparius, Aristida fasciculata, Astrebla pectinata, Bouteloua curtipendula, B. eriopoda, B. oligostachya, Brachypodium japonicum, Bromus unioloides, B. inermis, Bulbilis dactyloides, Chloris verticillata, Cynodon dactylon, Dactylis glomerata, Eriochloa punctata, Eriocoma cuspidata, Festuca duriuscula, F. elatior, F. ovina, F. rubra, Hilaria cenchroides, Lolium perenne, Panicum ciliatissimum, Paspalum compressum, P. distichum, Poa arachnifera, P. compressa, P. pratensis, P. trivialis, Secale cereale, Stenotaphrum dimidiatum.

LAWN GRASSES.

Agrostis coarctata, A. stolonifera, A. canina, Bulbilis dactyloides, Cynodon dactylon, Festuca heterophylla, F. rubra, Fourniera mexicana, Opizia stolonifera, Paspalum compressum, Poa nemoralis, P. pratensis, P. trivialis, Stenotaphrum dimidiatum, Zoysia pungens. (See paper on "Lawns and Lawn Making" in Yearbook of the Department for 1897.)

GRASSES FOR WET LANDS.

Agrostis alba, A. coarctata, A. vulgaris, A. stolonifera, Arundinaria macrosperma, A. tecta, Calamagrostis canadensis, Chætochloa magna, Distichlis spicata, Festuca rubra, Holcus lanatus, Lolium italicum, Oryza sativa, Panicularia americana, P. fluitans, P. nervata, Panicum crus-galli, P. molle, Paspalum compressum, P. distichum, Phalaris arundinacea, Poa flava, P. pratensis, Stenotaphrum dimidiatum, Zizania aquatica.

GRASSES FOR EMBANKMENTS.

Agropyron repens, Andropogon halepensis, A. squarrosus, Arundinaria macrosperma, Bromus inermis, Calamovilfa longifolia, Cynodon dactylon, Distichlis spicata, Festuca rubra, Imperata arundinacea, Panicum digitarioides, P. obtusum, P. repens, Paspalum compressum, P. distichum, Phalaris arundinacea, Phragmites vulgaris, Spartina cynosuroides, Stenotaphrum dimidiatum, Zoysia pungens.

GRASSES FOR HOLDING SHIFTING SANDS.

Agrostis coarctata, Ammophila arenaria, Andropogon hallii, Calamovilfa longifolia, Cynodon dactylon, Elymus arenarius, E. mollis, Eragrostis obtusiflora, Imperata arundinacea, Muhlenbergia pungens, Panicum amarum, P. repens, Redfieldia flexuosa, Spartina patens, Spinifex hirsutus, Stenotaphrum dimidiatum, Thuarea sarmentosa, Uniola paniculata, Poa macrantha, Zoysia pungens. (See paper on "Grasses as Sand and Soil Binders" in the Year-book of the Department for 1894.)

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[The English names printed in *italics* are the ones in most common use; these only appear in the text. The references are to the numbers, not to pages.]

BULLETIN No. 18. Agros. 46.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

STUDIES

ON

AMERICAN GRASSES.

A SYNOPSIS OF THE GENUS SITANION.

BY

JARED G. SMITH.

PREPARED UNDER THE DIRECTION OF F. LAMSON-SCRIBNER, AGROSTOLOGIST.

ISSUED JUNE 24, 1899.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF AGROSTOLOGY,
Washington, D. C., May 3, 1899.

SIR: I have the honor to transmit herewith the manuscript of a paper entitled "Synopsis of the genus *Sitanion*," prepared under my direction by Mr. Jared G. Smith, assistant agrostologist, and recommend the same for publication as Bulletin No. 18 of this division under the general title of "Studies on American Grasses."

Respectfully,

F. LAMSON-SCRIBNER,
Agrostologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

INTRODUCTION.

The many and striking differences presented by the specimens which have been referred to *Sitanion hystrix* (*Elymus sitanion*) have long been recognized, but no one has heretofore attempted to define or classify them. From the material in the herbarium of the Academy of Natural Sciences of Philadelphia, it is evident that Nuttall distinguished at least two species. These are shown in Plate I, the tickets attached to the specimens being in Nuttall's handwriting. The large amount of material in the National Herbarium, gathered from numerous and widely separated localities by many collectors, has afforded an excellent opportunity for a study of the variations which with the increase of the collection became more and more apparent, and the necessity of their classification more and more evident. The present paper, prepared by my direction, was undertaken to meet this necessity, and while the species here defined may require some modification after further studies in the field, and while some classed as species may eventually be reduced to varieties, the subject as presented can hardly fail to be of interest to the student of grasses and helpful in the close discrimination of the species of a critical group of plants.

Nuttall,[1] who first described the species of this genus, referred it to the European *Ægilops* and named his plant *Ægilops hystrix*. His description was carefully drawn up and his species can be readily recognized. A year later, Rafinesque[2] published his genus *Sitanion*, based upon a single species, which he named *Sitanion elymoides*. It has been found impossible to determine with certainty which of the species enumerated in the present paper was the one named by Rafinesque; it certainly was not, however, the grass described by Nuttall.

Our leading authorities, Bentham and Hooker,[3] Hackel,[4] and Baillon,[5] have all reduced *Sitanion* to a section of *Elymus*. The articulate rachis, readily breaking up at maturity, and the usually bifid or many parted and awned empty glumes are well-defined characters, distinguishing the species from *Elymus*, and justifying their separation as a distinct

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[1] Genera North American Plants, **1**: 86. 1818.

[2] Journ. Phys., **89**: 103. 1819.

[3] Genera Plantarum **3**: p. 1207.

[4] Die Natürlichen Pflanzenfamilien **2**: part 2, p. 88.

[5] Histoire des Plantes, Monographie des Graminées, 258.

genus. To be sure there are species so closely connecting *Elymus* with *Sitanion* that it is difficult to determine to which genus they ought to be referred, but the same is true in the case of *Elymus* and *Agropyron;* there are intermediates which may with equal propriety be placed either in the one genus or the other.

That there are forms connecting *Sitanion* with *Elymus* indicates their close relationship, but this fact does not afford sufficient reason for uniting them, and the paper here presented, describing the many species into which *Sitanion* may be divided, affords good evidence and ample justification for its separation.

F. Lamson-Scribner.

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CHARACTERS OF THE GENUS.

SITANION Rafinesque, in Journ. Phys., **89**: 103, 1819.
Ægilops Nutt., Gen. N. Am. Pl., **1**: 86, 1818; not Linn. (1737.)
Polyantherix Nees, in Ann. Nat. Hist., Ser. I, **1**: 284, 1838.

Cæspitose perennials with intravaginal innovations. Rhachis of the spike articulating at the nodes; spikelets rarely 1, usually 2, or sometimes 3 at each node, each subtended by 2 persistent empty glumes. Empty glumes all subulate, setaceous and entire; or lanceolate and bifid; or many-parted from near the base; with recurving or spreading, scabrous awns terminating each lobe. Flowering glumes all alike, lanceolate, acute, or that of the lowest floret sterile and resembling the subulate-setaceous long-awned empty glumes; entire or with a single terminal recurving or spreading awn, or trifid and 3-awned. Inflorescence a spike, or very rarely spiciform-paniculate. A genus endemic to western North America, containing 23 species.

NOTE: **Sitanion**, section *Elymoides*, consists of 4 species intermediate between this genus and *Elymus*. They are placed here tentatively, as being more closely allied to *Sitanion*.

ANALYTICAL KEY TO THE SPECIES.

* Empty glumes many-lobed; lowest floret sterile, subulate-setaceous.
† Culms robust, 6–9 dm. high, spike and florets large; awn of the flowering glume 8–10 cm. long .... 1. *S. jubatum.*
†† Culms 1–5 dm. high; spike and florets medium or small; awn of the flowering glume 2–7 cm. long.
‡ Leaves short, flat, divergent; the blades and sheaths villous. 2. *S. villosum*
‡‡ Leaves long, erect or ascending, involute, strigose or pubescent.
= Awns of the empty and flowering glumes about as long as the axis of the spike .... 3. *S. multisetum.*
= = Awns of the empty and flowering glumes shorter than the axis of the spike.
a Leaves of the innovations involute, filiform, pilose. 4. *S. polyantherix.*
b Leaves of the innovations involute, rather rigid, strigose. 5. *S. breviaristatum.*

** Some of the empty glumes 2-nerved, bifid from about the middle, the lobes abruptly divergent; lowest floret of one or both spikelets sterile and like the empty glumes, but inserted on the rhachilla and falling away with it.
† Only one spikelet at each joint with fertile florets.............. 6. *S. minus.*
†† Both spikelets bearing fertile florets.
‡ Sheaths and dorsal surface of leaves glabrous; glaucous.
a Low alpine plants.................................... 7. *S. rigidum.*
b Erect, densely cæspitose .... 9. *S. glabrum.*
c Erect, slender; flowering glume half as long as its awn. 10. *S. insulare.*
d Slender; innovations very numerous............ 13. *S. cæspitosum.*

‡‡ Leaves dorsally pubescent or scabrous.

§ Awn 2 to 3 times as long as the flowering glume. 11. *S. cinereum.*

§§ Awn at least 4 times as long as the flowering glume.

1. Innovations very numerous; culms slender. 12. *S. hystrix.*

2. Innovations few; culms robust.

a Culm leaves 2–8 cm. long; flat, rigid, obtuse, divaricate. 8. *S. californicum.*

b Culm leaves 1–2.5 dm. long, flexuous; flowering glume scabrous.............................15. *S. strigosum.*

c Culm leaves short, rigid, ascending, 5–10 cm. long; flowering glume smooth below, scabrous above. 14. *S. montanum.*

d Culm leaves rigid; flowering glume glabrous. 16. *S. molle.*

*** Empty glumes subulate-setaceous, entire; lowest floret hermaphrodite.

a Culm leaves very long, flexuous, filiform-involute........ 18. *S. longifolium.*

b Culm leaves short, rigid, spreading, or horizontally divaricate.

1 Flowering glume 1 cm. long, glaucous; culms robust. 17. *S. brevifolium.*

2 Flowering glume 7 mm. long, soft pubescent; culms low. 19. *S. pubiflorum.*

**** Empty glumes lanceolate, 2–5-nerved, entire or lobed.

† Lowest floret longer than the internodes of the rachis.

‡ Leaves flat, glaucous, more strongly nerved on the back than above, 5–8 mm. wide .... 20. *S. planifolium.*

‡‡ Leaves involute, more prominently nerved above than on the back, 2–3 mm. wide .... 21. *S. lanceolatum.*

†† Internodes of the rachis longer than the lowest floret.

1 One spikelet at each node..................... 22. *S. hanseni.*

2 Two spikelets at each node................. 23. *S. anomalum.*

DESCRIPTION OF THE SPECIES.

§ **Polyantherix.** (Nees, as a genus.) *Lowest flowering glume of one or both spikelets sterile, awnlike; empty glumes deeply cleft into from 3 to 11 or more setaceous awns.*

1. SITANION JUBATUM J. G. Smith, sp. nov.

Culms stout, erect, or ascending, 6 to 9 dm. high, robust, terete, smooth. Nodes glabrous. Lower sheaths hirsute, the upper ones minutely pubescent or when young sparsely hirsute, becoming smooth, much exceeding the internodes, open at the throat. Ligule cartilaginous, 1 mm. long. Blade narrowly linear-lanceolate, 10 to 18 cm. long, 3 to 5 mm. wide, rather rigid, flat at the base, involute toward the acuminate apex, strigose-pubescent throughout, sparsely hirsute above and on the back toward the base, finely nerved above, with the midnerve prominent beneath. Spike 1 to 2 dm. long, often more than 1.5 dm. in diameter to the tips of the spreading awns, densely flowered, exserted or the basal portion inclosed in the uppermost leaf sheath. Empty glumes 4, 3- to many-parted from about the middle, the lobes setaceous, from 1 to 10 cm. long. Spikelets 2 at a node, each 2- to 4-flowered, the lowest sterile, the second hermaphrodite, the uppermost staminate or sterile. Flowering glume linear-lanceolate, acute, 8 to 10 mm. long, smooth and shining below, 5-nerved from about the middle, sparsely scabrous above, trifid at the apex, the lateral lobes setaceous, the middle one prolonged into a slender, scabrous, subflexuous awn, 8 to 12 cm. long. Internodes of the rachis 5 to 7 mm. long, compressed or plano-convex, spatulate, glabrous.

Type collected by Robert M. Horner, No. 573, Waitsburg, Wash., May 27, 1897, distributed as "*Elymus sitanion jubatum.*" Also collected by Frank W. Hubby, No. 48, among rocks, Ojai Valley, California, May 7, 1896.

SITANION VILLOSUM J. G. Smith. Type.

This grass is the largest and most robust species of *Sitanion*. It belongs to the *S. multisetum* group, differing from all other species in the very large spike and exceptionally long awn of the flowering glume.

2. **SITANION VILLOSUM** J. G. Smith, sp. nov. Pl. I.

Culms stout, erect, or slightly geniculate, 2 to 3 dm. high, densely leafy at the base, forming close, matted tufts. Sheaths rather densely hirsute, the lower strict, the uppermost somewhat inflated, scabrous. Ligule almost obsolete. Blades short, rigid, ascending or divaricate, finely strigose-pubescent and more or less densely hirsute, scabrous along the cartilaginous margins, linear-lanceolate, acuminate, pungently-pointed, 4 to 8 cm. long, about 3 mm. wide, flat, or at length involute. Spike 6 to 8 cm. long, subflexuous, its base inclosed in the greatly elongated uppermost leaf-sheath. Empty glume 3- to 7- or 8-parted from near the base, each lobe a very slender, scabrous, divaricate awn from 2.5 to 8 cm. long. Lowest floret usually sterile, its glume many-parted, like the empty glumes. Perfect florets 1 or 2. Flowering glume about 8 mm. long, obliquely lanceolate, smooth and shining at the base, scabrous for the upper two-thirds, 3-awned, the middle awn rather stout, divergent, 8 to 10 cm. long, the lateral ones very slender, 5 to 10 mm. long Palea as long as the flowering glume, obtuse, acute, or with two short, slender awns at the apex. Internodes of the rachis 4 to 5 mm. long, linear-compressed, glabrous.

Type collected by A. D. E. Elmer, No. 266, on rocky hilltops, Almota, Whitman County, Wash., June 13, 1896; also collected by C. V. Piper, No. 2598, on dry, gravelly prairies, Spokane, June 25, 1897; and Robert M. Horner, No. 574, Waitsburg, Wash., June 3, 1897.

This species may be separated from *Sitanion polyantherix*, to which it is closely related, by the short, rigid, hirsute basal culm leaves.

3. **SITANION MULTISETUM** J. G. Smith, sp. nov.

Culms 3 to 5 dm. high, terete, striate, glabrous or minutely strigose-pubescent, erect or slightly geniculate, much branched from the very base. Sheaths rather loose, open at the throat, scarious along the margins above, strigose-pubescent and hirsute on the back, mostly longer than the internodes. Ligule very short, membranaceous. Blades 5 to 10 cm. long, rigid, erect or ascending, linear, acute and pungently pointed, flat, becoming involute, sparsely hirsute on the back, scabrous on the margins, hirsute and scabrous along the prominent nerves above. Spike erect, 5 to 8 cm. long. Spikelets two at each node but usually only one bearing perfect florets. Empty glumes many-parted nearly to the base, the slender, ascending, scabrous awns varying from 1 to 5 or rarely 8 cm. long. Lowest flowering glume of the sterile spikelet subulate, resembling the segments of the empty glumes, but somewhat lanceolate at the base. Flowering glume of the fertile spikelet about 8 or 9 mm. long, linear-lanceolate, rounded on the back, smooth and shining below, keeled and scabrous above, 3-awned, the middle awn stout, rigid, scabrous, 5 to 6 cm. long, the lateral ones slender, 3 to 8 mm. long. Palea as long as the flowering glume, acute or bicuspidate. Internodes of the rachis compressed, spatulate above, smooth and shining, scabrous along the margins, 4 to 5 mm. long.

Type specimen collected by Coville and Funston, No. 1121, Tehachapi Valley, Kern County, Cal., June 25, 1891. Other specimens which may be referred to this are Samuels, No. 225, Sonoma County, Cal.; a specimen collected by Bolander at San Francisco without date or number; Dr. Palmer, No. 2422, Petaluma, 1892; Hansen, No. 617, Clinton, Amador County, June 30, 1893; a specimen marked "J. A. Allen, California;" and L. Schoenefeldt, No. 3439, Nachoguero Valley, Lower California, June 14, 1894.

It differs from *Sitanion polyantherix* and *S. breviaristatum* in the very much longer and more rigid, erect or ascending awns of the empty glumes, and the leaves hirsute dorsally toward the base and along the nerves above.

4. **SITANION POLYANTHERIX** J. G. Smith, new name. *Polyantherix hystrix* Nees, in Ann. Nat. Hist. 1: 284 (1838), not *Ægilops hystrix* Nutt.

Culms 3 to 4 dm. high, terete, striate, minutely strigose-pubescent. Sheaths striate, scabrous, closely enveloping the internodes and longer than them, hirsute. Ligule very short, membranaceous. Blades 6 to 25 cm. long, linear, long-attenuate or filiform, involute, acuminate, the lower hirsute on the back, the upper smooth, scabrous and sparsely hirsute on the nerves above. Spike 7 to 10 cm. long, rather rigid and densely flowered. Spikelets 2 at each node; all the florets of one of the spikelets sterile and the lowest and uppermost florets of the other either staminate or sterile, only the second producing seed. Empty glumes 5- to many-parted from near the base, the segments extending into slender, abruptly divaricate awns, 6 to 25 mm. long. Flowering glume of the hermaphrodite floret linear-lanceolate, acute, smooth and shining for its lower two-thirds, slightly scabrous above, with a rigid, scabrous awn 2.5 to 3 cm. long arising from between two minute teeth. Palea a little longer than the flowering glume, acute. Internodes of the rachis very short, smooth and shining, compressed, broadest above, about 3 mm. long.

Type collected by Douglas, in California. There is a specimen in the National Herbarium, labeled *Sitanion polyantherix*, which was collected by Dr. J. M. Bigelow, surgeon and botanist to Lieut. A. W. Whipple's expedition for a railway route from the Mississippi River to the Pacific Ocean, near the thirty-fifth parallel of latitude in 1853–54, California, without locality, and it is from this plant that the above description is drawn.

This species may be separated from *S. breviaristatum*, to which it is related, by the very long-attenuate, filiform leaves, and taller and more slender culms.

5. **SITANION BREVIARISTATUM** J. G. Smith, sp. nov.

Low, cæspitose perennial, with slender, erect spikes and very long, rigid, erect or ascending leaves. Culms about 2 dm. high, erect, clothed with dead leaf-sheaths at the base. Sheaths smooth, closely enveloping and longer than the internodes, scarious along the margins. Ligule nearly obsolete. Blades 5 to 15 cm. long, linear, rigid, pungently pointed, densely strigose-pubescent on both surfaces, closely involute. Spike slender, rigid, 3 to 6 cm. long. Empty glumes 2- to many-parted, bearing scabrous, flexuous, divergent awns, from 7 to 20 mm. long. Flowering glume about 6 mm. long, narrowly lanceolate, smooth below, scabrous above, tipped with a short, rigid awn from 1 to 1.5 cm. long. Palea as long as the flowering glume, acute, 2-nerved, scarious along the margins, bicuspidate. Grain adherent to the palea, elliptical, oblanceolate, 5 mm. long, compressed, acute at the base, rounded at the apex. Internodes of the rachis compressed, 4 to 5 mm. long, spatulate above, glaucous.

Type specimen collected by Coville and Funston, No. 833, Willow Creek Canyon, Panamint Mountains, California, May 22, 1891.

This species differs from *Sitanion multisetum* to which it is related, in the low, densely cæspitose habit; short, slender spikes; and very short awns of the empty and flowering glumes. The bases of the culms are clothed with papery leaf-sheaths.

§§ **Eusitanion.** *Lowest floret of one or both spikelets sterile and like the empty glumes; some of the empty glumes bifid from about the middle, the divisions divergent; the others entire, subulate-setaceous.*

6. **SITANION MINUS** J. G. Smith, sp. nov.

Culms 1.5 to 2 dm. high, slender, rigid, erect, terete, glabrous. Nodes glabrous. Culm leaves 5. Sheaths glabrous, closely enveloping and longer than the internodes. Ligule almost obsolete. Blades 5 to 7 cm., those of the innovations 8 to 12 cm. long, rigid, erect or somewhat divaricate, linear, acuminate, involute, smooth and glabrous on the back, scabrous on the margins, strigose-pubescent on the nerves above. Spikes 3 to 5 cm. long, slender, their bases included in the

upper leaf sheaths, closely-flowered. Empty glumes 4, subulate or one of the lateral ones often lanceolate and 2-nerved, bifid from above the middle, scabrous, 25 to 32 mm. long. Spikelets 2-flowered, both florets of one of them sterile, reduced to subulate awns. Lower floret of the other hermaphrodite, the flowering glume 5 mm. long, lanceolate, strongly nerved and scabrous above the middle, smooth below, entire, tipped by a slender scabrous, subflexuous awn about 3 cm. long. Palea as long as the flowering glume, bicuspidate. Second floret rudimentary, awned. Internodes of the rachis 2 to 3 mm. long, spatulate, glabrous.

Type collected by L. Schoenefeldt, No. 3277, International Boundary Commission, Jacumba Hot Springs, near monument 233, altitude 900 m., May 24, 1894.

Related to *Sitanion multisetum.*

7. SITANION RIGIDUM J. G. Smith, sp. nov.

Culms 1 to 2 dm. high, terete, striate. Nodes glabrous. Sheaths longer than the internodes, smooth and glaucous, or the lower ones hirsute, open at the throat. Ligule cartilaginous, 1 mm. long. Blades 3 to 8 cm. long, 2 to 3 mm. wide, rigid, involute, smooth and glaucous on the back, obtuse or acute at the apex, scabrous along the margins and nerves above. Spike 2 to 8 cm. long, ascending, exserted its own length, or the base included in the uppermost leaf-sheath; empty glumes 4 and entire, or 6 (*i. e.*, the two lateral ones at each node divided to the very base) awned, strongly divaricate, 2 to 3 cm. long. Lowest floret sometimes sterile, like the empty glumes. Spikelets few-flowered. Flowering glume 7 to 9 mm. long, linear-lanceolate, trifid, smooth and glaucous below, scabrous above, tipped with a stout, divergent awn 3 to 4 mm. long. Internodes of the rachis 3 to 4 mm. long, compressed, scabrous on the margins.

Type collected by O. D. Allen, No. 178, Cascade Mountains, Washington, 1896. Other specimens examined are Elmer, No. 1145, Washington, 1898; and G. R. Vasey, Washington, 1889; H. E. Brown, No. 372, north side of Mount Shasta, California, 1897; R. M. Horner, No. 579, Blue Mountains, Washington, July 29, 1897; A. Nelson, No. 1021, Union Pass, Wyoming, August 13, 1895; J. N. Rose, No. 271, Timber Reserve, northwest Wyoming, August 28, 1893; Frank Tweedy, No. 79, Teton Forest Reserve, Wyoming, July, 1897; and S. Watson, No. 1337, E. Humboldt Mountains, Nevada, August, 1868.

This grass is related to *S. glabrum*, differing in the dwarf habit of growth and rigid glaucous leaves.

8. SITANION CALIFORNICUM J. G. Smith, sp. nov.

Culms low, ascending, 1.5 to 2.5 dm. high, terete, striate, densely pubescent above, geniculate at the nodes. Sheaths longer than the internodes, the lower ones densely hirsute, the upper minutely puberulent, the uppermost many times longer than the blade. Ligule obsolete. Blade 2 to 8 cm. long, 3 to 4 mm. wide, rigid, divaricate or ascending, prominently striate, linear-lanceolate, abruptly contracted at the base, attenuate toward the obtuse or subacute apex, scabrous above and on the margins, densely puberulent on the back. Spike subflexuous, erect or ascending, loosely few-flowered, 5 to 8 cm. long, barely exserted or the base inclosed in the uppermost leaf-sheaths. Lowest floret of one of each pair of spikelets sterile. Empty glumes 4, entire, subulate-setaceous, divaricate, 3 to 5 cm. long. Flowering glume linear, acute, abruptly rounded at the base, 10 to 12 mm. long, finely scabrous, terminating in a stout, divaricate, scabrous awn about 4 cm. long, arising from between two minute lateral setæ. Palea 2 mm. shorter than the flowering glume, truncate or obtuse, scabrous on the nerves above. Internodes of the rachis compressed, 4 to 5 mm. long, scabrous throughout.

Type collected by S. B. Parish, No. 3295, San Bernardino Mountains, California, altitude 2,150 m., June 23, 1894. Closely related to *S. rigidum*, but with leaves pubescent throughout and longer flowering glumes.

9. SITANION GLABRUM J. G. Smith, sp. nov.

Culms erect, terete, smooth and shining, glaucous. Sheaths glaucous, glabrous, rather closely enveloping and shorter than the internodes, scarious along the margins, open at the throat. Ligule membranaceous, almost obsolete. Blades 7 to 15 cm. long, 2 to 5 mm. wide, broadly linear, acute, flat becoming involute, smooth and glabrous on the back, scabrous-pubescent along the nerves above. Spike 5 to 8 cm. long, slender, subflexuous, its base inclosed in the swollen uppermost sheath. Empty glumes bifid from the very base, the lobes subulate, setaceous, 6 to 8 cm. long, subflexuous, slender, divaricate. Flowering glume 7 to 8 mm. long, rounded on the back, smooth and shining for its lower two-thirds, linear-lanceolate, acute, entire or minutely bifid at the apex, tipped with a slender, rigid, setaceous awn 4 to 5 cm. long. Palea as long as the flowering glume, bidentate, scabrous on the nerves above. Internodes of the rachis obcuneate, compressed, about 3 mm. long.

Type collected by Coville and Funston, No. 914, near Crystal Spring, Coso Mountains, California, June 12, 1891. Also collected by J. A. Allen, California, without date or locality. No. 821, Hall, San Jacinto Mountains, may be placed here; and also Purpus, No. 5289, Pah Mountains, 1897. The latter has the habit of typical *S. glabrum*, but the leaves and sheaths are minutely soft pubescent and the spikelets and empty glumes purplish. Other specimens examined are: L. Schoenefeldt, No. 3609, Laguna, Cal., June 14, 1894; and C. V. Piper, No. 1952, dry slopes Mount Rainier, Wash. 2,100 m., August, 1895.

10. SITANION INSULARE J. G. Smith, sp. nov.

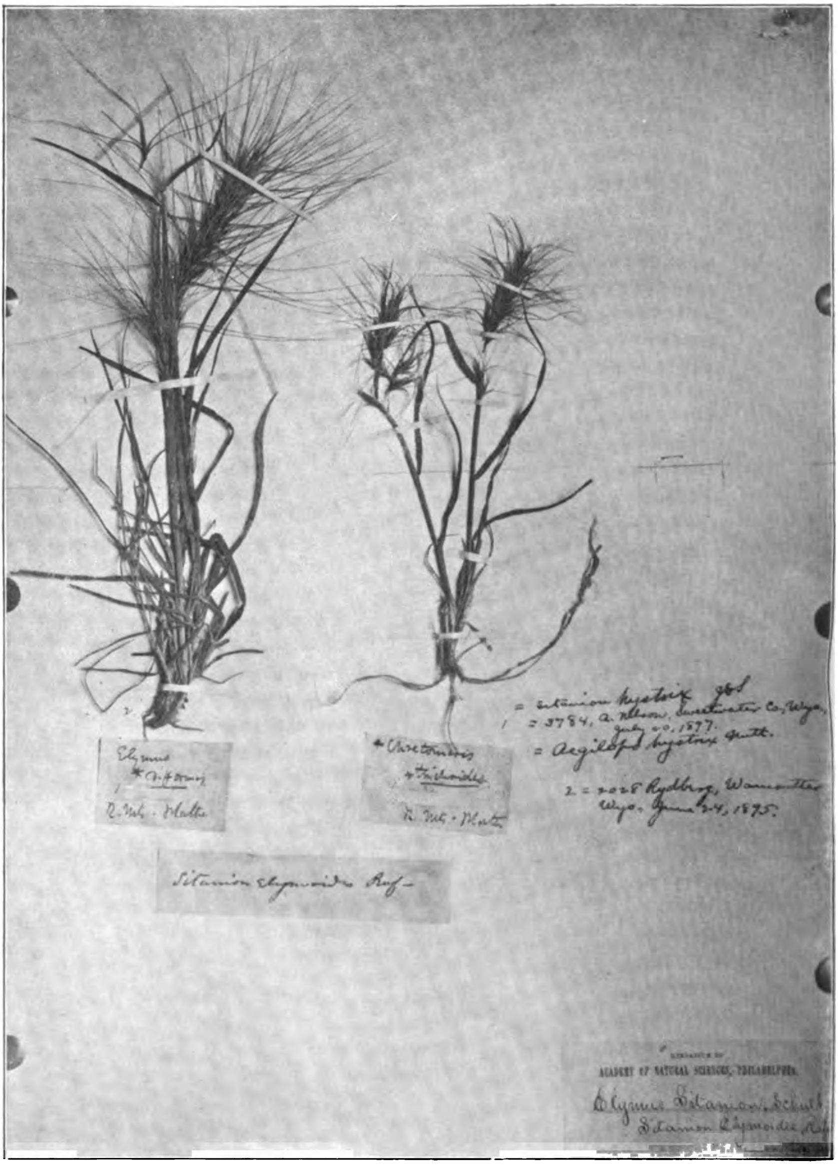
Culms slender, erect, terete, glabrous. Nodes glabrous. Culm leaves 4 or 5. Sheaths glabrous, closely enveloping the culm, open at the throat, shorter than the internodes. Ligule almost obsolete. Blades linear, 1 to 1.5 dm. long, glabrous on the back, strongly nerved and strigose-pubescent on the nerves above, scabrous along the margins. Spike slender, 5 to 8 cm. long. Empty glumes lanceolate, bifid and 2-awned, 4 to 5 mm. long, 2 mm. wide, tipped with divergent, slender, scabrous awns, 10 to 20 mm. long. Flowering glume 8 mm. long, linear-lanceolate, smooth and shining, glabrous for the lower two-thirds, rounded on the back below, keeled above, 3-toothed, the middle nerve extending into a stout, scabrous, divaricate awn about 15 mm. long; lateral teeth 1 to 2 mm. long. Palea as long as the flowering glume, 2-toothed at the apex. Internodes of the rachis linear, dilated above, sharply 2-edged, scabrous on the margins, 7 to 10 mm. long.

Type collected by Sereno Watson, No. 1338, Carrington Island, Salt Lake, Utah, June, 1869.

This species is quite distinct from any other in the National Herbarium. It has the broad empty glumes of *Elymus*, but two-parted, as in *Eusitanion*, with divaricate awns. The empty glumes are inserted as in *Sitanion*, while the form of the spikelets and the habitat of the infloresoence resembles some species of *Agropyron*. As in the other *Sitanion* species the rachis breaks up into segments at maturity.

11. SITANION CINEREUM J. G. Smith, sp. nov.

Slender, ascending, leafy perennial, 2 to 3 dm. high, the entire plant ashy-gray with a close, dense pubescence. Innovations as long as the culms. Culms slender, terete, pubescent. Nodes glabrous. Sheaths closely enveloping the internodes and shorter than them, densely ciliate-pubescent. Ligule almost obsolete. Blades linear, rigid, involute, the uppermost 5 to 7, the lower 15 to 20 cm. long, densely strigose-pubescent on the nerves above, soft-pubescent or hirsute below. Spike slender, 4 to 5 cm. long. Empty glumes very scabrous, bifid, 2-awned, the strongly divergent scabrous awns 2 to 3 cm. long. Flowering glumes 7 to 8 mm. long, rounded on the back, scabrous throughout, 3-nerved toward the apex, 3-awned, the lateral awns very slender, 2 to 4 mm. long, the middle one stout,



SITANION HYSTRIX (Nutt.) J. G. Smith.

Photograph of Nuttall's type in the Herbarium of the Philadelphia Academy of Science.

divaricate, 2 to 3 cm. long. Palea as long as the flowering glume, tipped with two slender scabrous awns. Internodes of the rachis scabrous along the margins; 2 to 4 mm. long.

Type collected by S. M. Tracy, No. 222, Reno, Nev., 1887.

It differs from any other specimen in the National Herbarium in being densely grayish-pubescent throughout. In the character of the spikelets it approaches *S. hystrix*. No. 127, Suksdorf, Bickleton, Yakima County, Wash., June 7, 1884, with similar leaves and inflorescences, but the plant less densely pubescent and quite glaucous, may be placed here. Also a specimen collected by Dr. C. H. Merriam on Mount Shasta, California, 1898.

12. **SITANION HYSTRIX** (Nutt.) J. G. Smith, new combination. (*Ægilops hystrix* Nutt. Gen. N. Am. Pl., **1**: 86, 1818.) Pl. II.

Culms 1 to 3 dm. high, slender, erect or ascending, scabrous above, clothed at the base with papery leaf-sheaths. Innovations very leafy, one-third to two-thirds the length of the culms. Sheaths striate, strigose-pubescent, open at the throat, closely enveloping the internodes. Ligule almost obsolete. Blades narrowly linear, flat or at length involute, strigose-pubescent throughout, prominently 9-nerved, scabrous along the margins, erect or ascending; those of the innovations 7 to 12 cm. long, 1 to 2 mm. wide; culm leaves about as long, 2 to 4 mm. wide. Spike 5 to 7 cm. long, erect or subflexuous, exserted, or its basal portion inclosed in the uppermost leaf-sheath, closely flowered. Spikelets 3- to 4-flowered, compressed. Empty glumes bifid, from near the base and unequally 2-awned; the strongly scabrous, glaucous, divergent awns, 3 to 4 cm. long. Flowering glume 7 to 8 mm. long, linear-lanceolate, minutely pubescent, 3-awned, the middle awn rather slender, recurved, about 3 cm. long. Palea as long as or longer than the flowering glume, scabrous, tipped with two slender awns, 2 to 3 mm. long. Internodes of the rachis glaucous, linear, not at all dilated above, about 5 mm. long.

A common, worthless bunch grass on shale hills and among the sagebrush on the high plains from western Colorado to eastern Washington.

Specimens examined: *Wyoming:* P. A. Rydberg, No. 2028, Wamsutter, July 24, 1895; C. L. Shear, No. 280½, Wamsutter, June 24, 1895; No. 283, Green River, June 25, 1895; Thomas A. Williams, No. 2437, dry rocky hillsides, Evanston, July 10, 1897; No. 2379, dry sagebrush hills, Green River, July 9, 1897; Aven Nelson, No. 3058, Green River Hills, May 31, 1897; No. 3669, Wamsutter, July 10, 1897; No. 3784, North Vermilion Creek, July 20, 1897.

Washington: C. V. Piper, No. 2579, on sagebrush land, Ellensburg, July 9, 1897. A. B. Leckenby, Walla Walla, July 12, 1898.

Colorado: John Wolfe, No. 623, 1873; C. Thomas, 1869; and F. E. Clements, No. 60, Walsenburg, July 10, 1896.

There are in the herbarium of the Philadelphia Academy of Science two of Nuttall's specimens of *Sitanion*. One of these, labeled "*Chretomeris trichoides*, R. Mts. Platte," is exactly identical with No. 3784, A. Nelson, and No. 283, C. L. Shear, both collected in the Red Desert of Wyoming. The other, labeled "*Elymus difformis*, R. Mts. Platte," is nearly identical with No. 2028, Rydberg, from Wamsutter, Wyo. If these specimens are those from which Nuttall's description of *Ægilops hystrix* was drawn, and they agree better with his description than any specimen from the "arid plains of the Missouri" so far examined, then there was undoubtedly a mistake made in referring the habitat of this to that locality.

I am assured by Dr. E. L. Greene that it is highly improbable that Rafinesque drew his description of *S. elymoides* from Nuttall's plant, and it is certain that Rafinesque's description (Journ. Phys. **89**: 1819) differs in important particulars from that of *Ægilops hystrix*, Nuttall. I am, however, unable definitely to identify any *Sitanion* with which I am familiar as the true *S. elymoides*, Raf. The locality, "Missouri," of 1819, was then applied to what now constitutes several large

States in which a dozen or more separate species occur. Rafinesque apparently left no type, and the original description is too fragmentary to enable one to more than guess at the identity of the plant which he described.

13. **SITANION CÆSPITOSUM** J. G. Smith, sp. nov.

Densely cæspitose, with flat leaves, and weak, ascending culms. Sterile shoots very leafy, erect or spreading, 1 to 2 dm. long. Culms 2 to 3 dm. high, very slender, terete, glabrous. Nodes glabrous. Sheaths striate, open at the throat, smooth and glabrous. Ligule membranaceous, entire, very short. Blades 4 to 10 cm. long, 2 to 3 mm. wide, linear, flat, or the margins incurved, prominently 7-nerved above, glabrous on the back, scabrous above. Spike 4 to 6 cm. long, its base sometimes inclosed in the uppermost sheath, mostly exserted, somewhat flexuous. Empty glumes entire or bifid, 3 to 4 cm. long, divaricate, scabrous. Flowering glume of the lowest fertile floret linear-lanceolate, entire, smooth and shining below, sparsely scabrous above the middle, about 7 mm. long, tipped with a flexuous scabrous awn, about 5 mm. long. Callus rounded, glabrous. Palea as long as the flowering glume, rounded at the apex. Joints of the rachis glabrous, except along the margins, not at all dilated above, two-thirds the length of the lowest floret.

Growing in rich soil in the canyons around Silver City, N. Mex.

Type specimens collected by Jared G. Smith, near Cliff, N. Mex., August 19, 1897. Also collected at the same locality in August, 1896. It grows only in shaded canyons, and on moist talus slopes in the mountains at an altitude of about 2,000 m. Its leaves continue green during the winter. It is one of the "mutton grasses," formerly abundant and highly valued as forage for sheep and cattle, now to be found only in protected situations. Probably also occurring in the mountains of western Texas, although there are no specimens from any other locality than the typical one in the National Herbarium.

Closely related to *S. hystrix* (Nutt.) JGS., but the sheaths and blades are glabrous on the back.

14. **SITANION MONTANUM** J. G. Smith, sp. nov.

Culms rather stout, erect, 2 to 4 dm. high, terete, striate, glabrous below, scabrous above. Sheaths rather loose, open at the throat, as long as, or longer than, the internodes, smooth, scabrous or pubescent. Blades 5 to 10 cm. long, 3 to 4 mm. wide, linear, acuminate, flat or involute, pubescent on the back, scabrous or strigose-pubescent on the prominent nerves above, scabrous along the margins, rigid, erect or ascending, the uppermost usually shorter than the spike. Spike erect, loosely flowered, 5 to 10 cm. long. Empty glumes subulate, scabrous, long-awned, some of those in the lower part of the spike unequally bifid, the lobes extending into scabrous, divergent awns 5 to 6 cm. long, 2 or often 3 spikelets at each node. Lowest floret sterile. Flowering glumes 10 to 11 mm. long, linear-lanceolate, rounded on the back, smooth and shining for the lower third, scabrous above and on the margins, trifid, three-awned, the scabrous, divergent middle awn 4 to 7 cm. long, the lateral awns very short, slender. Palea as long as the flowering glume, with two short, setaceous, scabrous awns, or sometimes rather obtuse and muticous. Internodes of the rachis linear or dilated above, compressed, glaucous, 4 to 6 mm. long.

S. montanum differs from *S. strigosum* in the shorter, flat, and more rigid erect leaves and smoother flowering glume. This may be Rafinesque's *S. elymoides.*

Northern Wyoming and Montana to Oregon. SPECIMENS EXAMINED: *Montana:* F. Lamson-Scribner, No. 437, gravelly bottoms, Indian Creek, July 4, 1883; rather densely cinereous-pubescent throughout. P. A. Rydberg, No. 3091 (type), Spanish Creek, July 15, 1896; and No. 3133, Spanish Basin, July 18, 1896. Thomas A. Williams, No. 2002, Spanish Creek Basin, July 16, 1896, on sterile, rocky soil.

Wyoming: Thomas A. Williams, No. 2776, Bull Camp, August 2, 1897; and No. 2596, Ten Sleep Lakes, Big Horn Mountains, August 19, 1897.

SITANION BREVIFOLIUM J. G. Smith. Typical.

Idaho: B. W. Everman, No. 319, shores of Petit Lake, August 13, 1895.

Oregon: A fragmentary specimen collected by the U. S. South Pacific Exploring Expedition, under the command of Captain Wilkes, 1838–1842, is doubtfully referred here.

15. **SITANION STRIGOSUM** J. G. Smith, sp. nov.

Culms stout, erect, 3 to 6 dm. high, terete, striate, glabrous, the uppermost internodes minutely pubescent. Nodes brownish, glabrous. Sheaths open at the throat, loose, striate, scarious along the margins above, more or less densely pubescent, as long as or longer than the internodes. Ligule nearly obsolete. Blades 1 to 2.3 dm. long, 3 to 6 mm. wide, linear to linear-lanceolate, flat or the lower ones involute, rounded at the base, long-acuminate pointed, strongly nerved, strigose-pubescent throughout, sparsely hirsute along the nerves, scabrous on the cartilaginous margins. Spike stout, erect, exserted, 8 to 12 cm. long. Empty glumes with the awn 5 to 6 cm. long, entire or bifid, scabrous, long-awned, divaricate. Flowering glumes 8 to 10 mm. long, lanceolate, rounded on the back, scabrous and glaucous, strongly 3-nerved above, the middle awn stout, recurved, scabrous, 5 to 7 cm. long, the lateral ones 1 to 2 mm. long. Palea nearly as long as the flowering glume; bifid, with two short awns, ciliate along the nerves above.

Type collected by P. A. Rydberg, No. 3298, Sheep Creek, Montana, August 8, 1896. Also collected by Charles A. Geyer, June 10, 1839, "in heavy ferruginous loam, Missouri, James and Shienne River valleys," probably at the eastern border of the Bad Lands, above Mandan, N. Dak.

S. strigosum differs from *S. montanum* in the very long, less rigid, more strongly nerved culm leaves, the uppermost nearly as long as or much exceeding the spike, those of the innovations half the length of the culm. The flowering glumes are more scabrous and shorter. This may be Rafinesque's *S. elymoides.*

16. **SITANION MOLLE** J. G. Smith, sp. nov.

Culms stout, erect, rigid, 3 to 4 dm. high, clothed at the base with dead leaf-sheaths, terete, striate, pubescent. Innovations about half as long as the culm. Nodes glabrous. Sheaths rather loose, open at the throat, longer than the internodes, pubescent, the lower ones sparsely hirsute along the nerves, the upper puberulent and scabrous on the nerves. Ligule entire, almost obsolete. Blades rigid, erect or ascending, linear, long-acuminate pointed, 8 to 15 cm. long, 3 to 5 mm. wide, the uppermost longer than the spike, soft-pubescent throughout, scabrous along the cartilaginous margins, on the nerves above and along the midrib beneath. Spike 7 to 8 cm. long, erect, loosely flowered, shortly exserted. Empty glumes 4, entire or unequally bifid, subulate-setaceous, 6 to 7.5 cm. long, scabrous, divaricate. Lowest floret of one of the spikelets sterile and like the empty glumes. Flowering glume of the lowest hermaphrodite floret linear-lanceolate, acute, 1 cm. long, smooth and shining, glaucous, trifid, or entire, tipped with a stout, spreading, scabrous awn 5 to 7 cm. long. Palea as long as the flowering glume, acute, or bicuspidate scabrous along the nerves.

Type collected by Shear and Bessey, No. 1469, East Side Buffalo Pass, Larimer County, Colo., moist, open mountain side, 3,200 m. August 14, 1898.

S. molle is related to *S. montanum.* It differs in being finely pubescent throughout. The leaves are longer and less strongly nerved.

§§§ **Hordeiformae.** *Lowest floret hermaphrodite. Empty glumes 4, entire.*

17. **SITANION BREVIFOLIUM** J. G. Smith, sp. nov. Pl. III.

Culms 3 to 6 dm. high, terete, stout, erect, obscurely striate, glaucous. Innovations less than half the length of the culms. Nodes glabrous. Sheaths smooth, scarious along the margins, glaucous, longer than the internodes, the uppermost much elongated, the lower sometimes pubescent or hirsute. Ligule almost

obsolete. Blades 5 to 10 or rarely 12 cm. long, 3 to 4 mm. wide, linear, acuminate, flat or involute, rigid, divergent or ascending, smooth and glaucous on the back, scabrous-pubescent along the prominent nerves above. Spike 7 to 15 cm. long, loosely few-flowered, long-exserted. Empty glumes stout, setaceous, divergent, 5 to 9 cm. long, smooth and shining and often glaucous at the base, scabrous above. Flowering glumes 8 to 10 mm. long, linear-lanceolate, glaucous, scabrous throughout, rounded on the back below, nerved above, entire, tipped with a stout, scabrous, spreading awn 4 to 8 cm. long. Palea as long as the flowering glume, scabrous on the margins above, obtuse. Joints of the rachis compressed, glaucous, 5 to 10 mm. long, linear. Closely related to *S. longifolium*, but the culm leaves shorter and more rigid and the innovations less than half as long as the culms.

Type collected by J. W. Toumey, No. 797, Tucson, Ariz., 1892.

SPECIMENS EXAMINED, *Colorado:* Tracy, Earle & Baker, No. 4274, Hamors Lake, July 24, 1898; No. 429, Mancas, July 8, 1898; No. 4272, Durango, July 18, 1898. C. L. Shear, No. 1087, Breckenridge, August 29, 1896; No. 1070, Dillon, August 26, 1896; No. 612, Georgetown, August 17, 1896; No. 997, Westcliffe, August 12, 1896; No. 912, Marshall Pass, July 27, 1896; No. 1003, Buena Vista, August 15, 1896; No. 814 and 833, Veta Pass, July 13, 1896; No. 1096, Como, September 1, 1896; No. 1240, Animas Canyon, August 5, 1897. P. A. Rydberg, No. 2414, Georgetown, August 20, 1895; No. 2509, Boulder, September 3, 1895. Shear & Bessey, No. 1407, Egeria Park, August 4, 1898. Patterson, Georgetown, 1875.

Wyoming: Thomas A. Williams, No. 2573*a*, Iron Mountain, July 2, 1897, and No. 2621, Bear Lodge, July 23, 1897; A. Nelson, No. 3952, Albany County, August 9, 1897.

Utah: Marcus E. Jones, No. 5663*bd*, Marvine Laceolite, July 23, 1894; No. 5684*bb*, Mount Ellen, Henry Mountains, July 25, 1894, and 5770*p*, Fish Lake, August 7, 1894.

18. **SITANION LONGIFOLIUM** J. G. Smith, sp. nov.

Culms 3 to 5 dm. high, stout, ascending, somewhat geniculate at the base, glaucous. Leaves of the innovations 1.5 to 3 dm. long, attenuate, involute, often as long as the culms. Nodes glabrous. Sheaths scabrous and glaucous, or more or less strigose-pubescent, or sparsely hirsute, longer than the internodes, loose, open at the throat, scarious along the margins above. Ligule entire, almost obsolete. Blades linear, long, attenuate, acuminate, striate, smooth and glaucous or pubescent, or sparsely hirsute on the back, 1 to 2 dm. long, 1 to 3 or 4 mm. wide. Spike subflexuous or somewhat nodding, 1 to 1.3 dm. long, rather loosely flowered, its base inclosed in the inflated uppermost leaf-sheath. Spikelets 2 or rarely 3 at each node. Empty glumes subulate setaceous, divaricate, scabrous, 6 to 8 cm. long. Flowering glumes 8 to 11 mm. long, scabrous, glaucous, rounded on the back below, keeled above, entire or minutely trifid, tipped with a stout, scabrous divaricate awn 5 to 6.5 cm. long. Palea as long as the flowering glume, obtuse or bicuspidate, scabrous on the nerves above. Internodes of the rachis compressed, glaucous, 6 to 8 mm. long. Closely related to *S. brevifolium*, from which it may be distinguished by the long attenuate flexuous leaves of the culms and innovations and by the subflexuous spikes, inclosed at the base in the uppermost leaf-sheaths.

Type collected by C. L. Shear, No. 1213, near Silverton, Colo., August 4, 1897, among rocks on the open sides of a canyon, altitude 3,000 m.

SPECIMENS EXAMINED, *Colorado:* J. Wolfe, No. 1161-2-3, Denver, 1873. C. L. Shear, No. 1152 and No. 1158, Ouray, July 4, 1897; No. 886, Villa Grove, July 24, 1897; No. 836, Veta Pass, July 15, 1896; No. 717, Idaho Springs, August 27, 1895. M. E. Jones, No. 531, Idaho Springs, August 1, 1878. Tracy, Earle & Baker, No. 4275, Chicken Creek, July 6, 1898. P. A. Rydberg, No. 2497, Idaho Springs, August 28, 1895.

Kansas: C. H. Thompson, No. 21, Ulysses, June 26, 1893.

Wyoming: D. Griffiths, Nos. 493 and 500, Sundance, August 10, 1897; No. 576, Little Missouri Buttes, August 15, 1897; No. 669, Inyankara Mountain, August 23, 1897; A. Nelson, No. 1602, Laramie Peak, August 6, 1895.

Nevada: Shockley, without date or locality.

Arizona: Dr. Palmer, No. 534, 1876. G. C. Nealley, No. 171, Rincon Mountains, August, 1891.

New Mexico: C. Wright, No. 2076, in part, 1851-52. E. O. Wooten, No. 322, White Mountains, August 12, 1897.

Texas: J. Reverchon, Upper Concho River (Curtiss, No. 3536).

19. **SITANION PUBIFLORUM** J. G. Smith, sp. nov.

Low, cæspitose perennial, with stout, rigid, erect culms, 2 to 3 dm. high, and tufted, erect, rigid innovations, 1 to 1.5 dm. long. Culms terete, strigose-pubescent above. Culm leaves 3 to 5. Nodes glabrous, glaucous. Sheaths about as long as, or longer than, the internodes, open at the throat, not at all inflated, glabrous. Ligule obsolete. Blades puberulent on the back, rigid, linear-involute, pungently-pointed, scabrous above, the lowest 10 cm., the uppermost 1.5 to 4 cm. long and horizontally spreading or divaricate. Spike exserted, erect, about 5 cm. long. Empty glumes setaceous, divaricate, 4 to 6 cm. long, scabrous throughout, not at all lobed or divided. Spikelets 2½-flowered, the uppermost floret rudimentary. Flowering glume of the lowest floret 7 mm. long, linear-lanceolate, acute, with a rounded callus, scabrous and finely pubescent, tipped with a straight, erect, scabrous awn, 5 to 6 cm. long. Palea rounded or entire at the apex, as long as the flowering glume, scabrous along the margins. Joints of the rachis one-half to two-thirds as long as the lowest floret, dilated above, scabrous.

Arizona, New Mexico, and southeastern Colorado: Type No. 795, J. W. Toumey, Tucson, Ariz., 1892. Other specimens of this are No. 38, Toumey, south of Ashfork, Ariz., June 25, 1892; C. R. Orcutt, No. 2533, Congress, Ariz., April 21, 1896. A specimen from the Moqui country without data. A. A. & E. G. Heller, No. 3558, Santa Fe, N. Mex., May 21, 1897. C. S. Crandall, No. 535, Trinidad, Colo., May 13, 1892.

This species is distinguished from *S. brevifolium* by the rigid, convolute, erect, puberulent leaves, densely tufted at the base of the low culms, erect spikes, and smaller pubescent flowering glumes.

§§§§**Elymoides.** *Empty glumes lanceolate, 2-5-nerved, entire or lobed, lowest floret hermaphrodite; spikelets 1 or 2 at a node, when 1, the empty glumes inclosing the spikelet as in Elymus and Agropyron; rachis of the spike articulate at the nodes.*

20. **SITANION PLANIFOLIUM** J. G. Smith, sp. nov.

Culms stout, erect, 5 to 6 dm. high, the lower internodes smooth and shining, glaucous, terete, the uppermost slightly striate, glabrous. Sheaths striate, glaucous, open at the throat, loose. Ligule obsolete. Blades 8 to 15 cm. long, 5 to 8 mm. wide, flat, lanceolate, becoming involute toward the acuminate apex, scabrous above, and along the cartilaginous margins, glabrous on the back, more strongly nerved below than above. Spike erect or somewhat nodding, 6 to 9 cm. long, purplish, long-exserted. Spikelets subcylindrical, compressed. Empty glumes 6 to 7 mm. long, lanceolate, strongly 1- to 3-nerved, entire or bifid, glaucous at the base, strongly scabrous on the nerves above, tipped with a slender, spreading, scabrous awn, about 2 cm. long. Flowering glume 10 to 11 mm. long, lanceolate, flat or rounded on the back, glaucous, sparsely and minutely scabrous, bearing a stout, scabrous awn 3 to 4 cm. long. Palea as long as, or slightly longer than, the flowering glume, glaucous, scabrous, obtuse at the apex. Joints of the rachis linear, compressed, dilated above, glaucous, 5 mm. long, very sharply 2-edged, scabrous on the margins.

Type collected by W. N. Suksdorf, No. 224, high mountains, Skamania County, Wash., August 10, 1896.

Closely related to *S. lanceolatum*, from which it differs in the glaucous sheaths and culms, flat, lanceolate leaves which are very smooth on the back, and the purplish, long-exserted spikes with glaucous florets.

21. **SITANION LANCEOLATUM** J. G. Smith, sp. nov.

Culms 2.5 to 5 dm. high, erect or ascending, and somewhat geniculate at the lower nodes. Culms terete, smooth and ascending, striate above. Nodes glabrous. Sheaths glabrous, striate, closely enveloping the culms, longer than the internodes. Ligule almost obsolete. Blades 8 to 15 cm. long, 2 to 3 mm. wide, rather rigid, linear, erect, or the basal ones divergent, flat or convolute, glabrous on the back, scabrous on the margins and nerves above. Spike erect, 6 to 10 cm. long, barely exserted, or its base included in the uppermost leaf-sheath. Spikelets cylindrical, subcompressed, the florets closely overlapping one another. Empty glumes 5 to 6 mm. long, keeled, lanceolate, 2-nerved, oblique, scarious on the margins, entire or unequally 2-awned, the longer awn scabrous, divergent, 10 to 15 mm. long. Flowering glume 8 to 9 mm. long, glaucous, rounded on the back, lanceolate, entire, or minutely 3-toothed at the apex, with a stout, scabrous, divergent awn 2 to 4 cm. long. Palea as long as its glume, obtuse or emarginate, scabrous on the margins above. Joints of the rachis, 5 to 7 mm. long, linear, spatulate, compressed, scabrous on the margins.

Type collected by P. A. Rydberg, No. 3381, Barker, Mont., August 17, 1896.

The habit of this grass resembles that of *Agropyron caninoides* Beal; the spikelets and empty glumes are arranged as in *Elymus*, but the nervation of the empty glumes, trifid flowering glume, and the rachis dehiscent at the nodes, are sufficient characters to throw this species into *Sitanion*.

22. **SITANION HANSENI** (Scribn.) J. G. Smith, nom. nov. *Elymus hanseni* Scribn. U. S. Dept. Agr., Div. Agros., Bull. **11**: p. 56. 1898.

"A rather stout, glabrous perennial, 9 to 12 dm. high, with narrow, spreading leaves and slender fragile spikes 5 to 8 cm. long. Sheaths smooth, striate. Ligule very short, hardly 1 mm. in length, entire. Leaf-blades 10 to 30 cm. long, 2 to 5 mm. wide. Internodes of the rachis about 1 cm. long. Spikelets 3- to 5-flowered, about 1.5 cm. long, exclusive of the awns. Empty glumes lanceolate, strongly nerved, tipped with 2, sometimes 3, unequal awns, the longer about 3.5 cm. First flowering glume 10 to 12 mm. long, entire or 2-toothed at the apex, terminating in a straight or very slender awn about 5 cm. long. Palea about the length of the glume, minutely scabrous on the sharp keels except at the base, slightly pubescent at the truncate or 2-toothed apex."

Amador County, Cal.

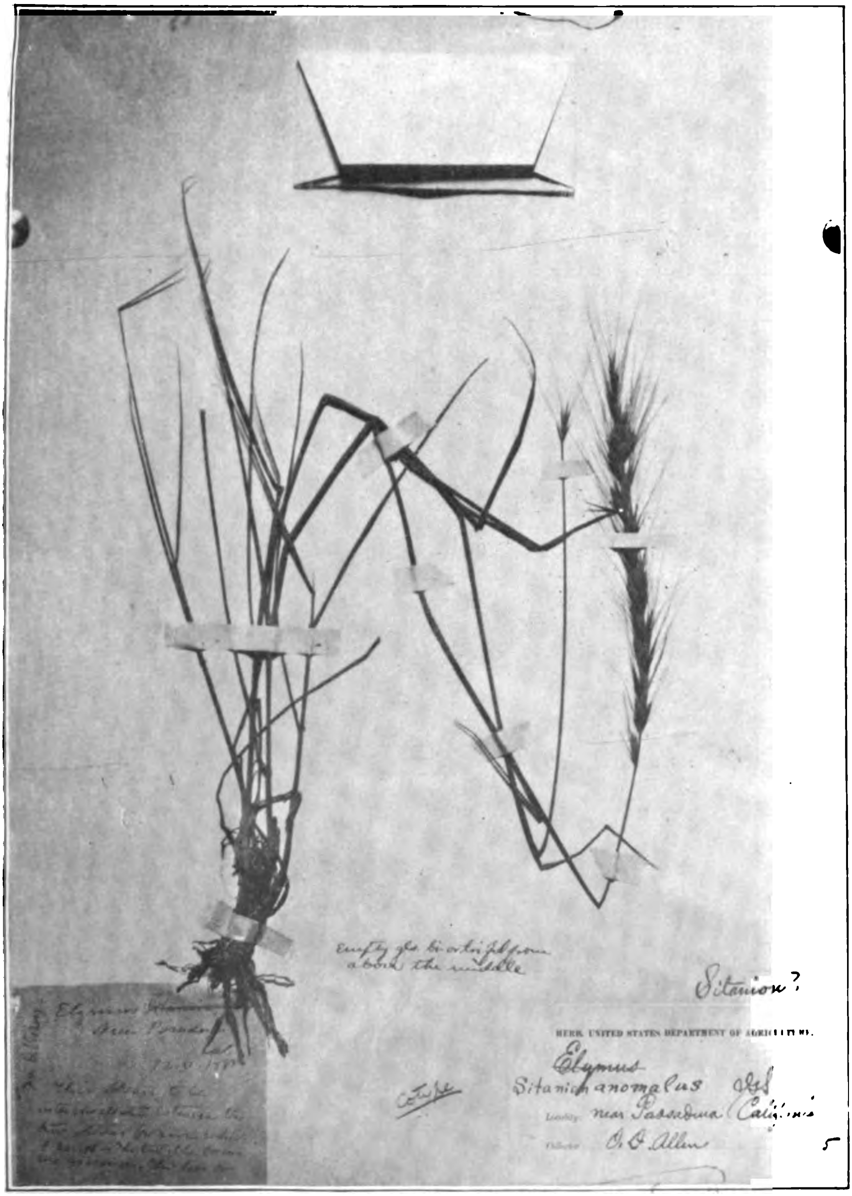
Related to *S. anomalum*, but taller and more slender, with mostly single rather remote spikelets, which are longer.

23. **SITANION ANOMALUM** J. G. Smith, sp. nov. (Pl. IV).

Culms erect or ascending, 5 to 6 dm. high, terete, smooth. Nodes glabrous. Sheaths smooth or the lower sparsely hirsute, ciliate along the margins, shorter than the internodes. Ligule membranous, 1 mm. long. Blades 4 to 12 cm. long, 3 to 4 mm. wide, involute, rigid, linear, long-attenuate, scabrous throughout. Inflorescence simple or thyrsiform, 1 to 1.5 dm. long, few-flowered, interrupted below, subflexuous. Spikelets compressed, 4-flowered, the florets distant. Empty glumes mostly lanceolate, entire, but those of the lowermost spikelets bifid above the middle, with short, scabrous, divergent awns 1 to 4 cm. long. Flowering glumes 1 cm. long, narrowly linear-lanceolate, rounded on the back, smooth below, scabrous above the middle, 3-aristate, lateral awns 1 to 2 mm. long, the middle one straight, erect, scabrous, 3 to 4.5 cm. long. Palea shorter than the flowering glume, obtuse, erose, or bidentate, scabrous along the margins and on the nerves. Internodes of the rachis 7 to 10 mm. long, ancipital, scabrous on the margins.

Type collected by O. D. Allen, near Pasadena, Cal., May 12, 1885. This grass is intermediate between true *Sitanion* and true *Elymus*. The habit is that of *Elymus*, but the articulate rachis, occasionally bifid empty glumes and trifid flowering glumes, indicate a close relationship with *Sitanion*.

DOUBTFUL SPECIES. *Sitanion elymoides* Raf.



SITANION ANOMALUM J. G. Smith. Cotype.

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BULLETIN NO. 19. Agros. 47.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

THE STRUCTURE OF THE CARYOPSIS OF GRASSES WITH REFERENCE TO THEIR MORPHOLOGY AND CLASSIFICATION.

BY

P. BEVERIDGE KENNEDY, Ph. D.

PREPARED UNDER THE DIRECTION OF F. LAMSON-SCRIBNER, AGROSTOLOGIST.

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GOVERNMENT PRINTING OFFICE.
1899.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Agrostology,
Washington, D. C., May 4, 1899.

Sir: I have the honor to transmit herewith and recommend for publication as Bulletin No. 19 of this Division the manuscript of a report on the structure of the caryopsis of grasses, ordinarily termed the grain or seed. This report, prepared by Mr. P. Beveridge Kennedy, by special authorization through the Agrostologist, contains much of histological interest, but is of special value on account of the important facts brought out in the investigations relative to the morphology and classification of grasses. Mr. Kennedy was formerly assistant chemist in Toronto University, Canada, and for the past three years has been studying at Cornell University, devoting special attention to the investigation of grasses.

Respectfully,

F. Lamson-Scribner,
Agrostologist.

Hon. James Wilson,
Secretary of Agriculture.

INTRODUCTION.

The fruits and seeds of plants present characters which are less subject to variation than any of the other organs or parts. In consequence, these characters are of the highest importance in studying the classification and relationships of plants. They are employed in separating the larger groups, and in some cases ordinal characters are based upon them; and within many families the fruit affords the best differential characters for the separation of subtribes, and even genera. To what extent the fruit, or caryopsis, of grasses may be employed in determining the relationships of the various tribes and genera is to some extent indicated in the following paper. Enough is presented to show that the characters possess great value in this connection and clearly emphasize the interest and importance of a knowledge of the structure and morphology of the caryopsis of the different tribes of Gramineæ—a subject here treated for the first time in the English language.

The structure of the fruits of the cereals has been investigated to some extent at a number of the agricultural colleges and experiment stations, but the cultivated grains only represent three of the thirteen tribes of grasses.

F. LAMSON-SCRIBNER.

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THE STRUCTURE OF THE FRUITS OF GRASSES WITH REFERENCE TO THEIR MORPHOLOGY AND CLASSIFICATION.

HISTORICAL REVIEW.

The first writer to mention the fruits of grasses from a morphological point of view was Malphigi,[1] who described the embryos of *Triticum* and *Avena* in 1687. He regarded the scutellum as representing the cotyledon. Nothing further was written concerning the embryo of grasses for a hundred years, when Gaertner[2] described it in 1788. He studied a considerable number of species, especially in regard to the scutellum. The name "scutellum" was first used by him. He regarded the "vitellus" as a transition between the endosperm and the cotyledon. A. L. de Jussieu[3] in describing the grass fruit used the term "lobus" implying the cotyledon.

In the year 1808 Poiteau[4] concluded that the sheath in the embryo, called "vitellus" and "scutellum" by Gaertner, is a true cotyledon. He decided that the epiblast must be the rudiment of a second cotyledon, because of its position opposite to the cotyledon or scutellum. Richard[5] in the same year presented the view that the scutellum originates from the lower part of the radicle, and that therefore the scutellum is a lateral protuberance of the radicle. By imagining the plumule raised in such a manner that it stands at right angles to the long axis of the scutellum, he constructed an homology with the embryos of the *Naiadaceæ*, *Alismaceæ*, *Hydrocharidaceæ*, and *Nymphaceæ*. The word epiblast originated with Richard. He regarded it as a continuation of the root sheath, basing his opinion on a section cut obliquely through the embryo of *Oryza*.

In 1809 Kirbel[6] compared a number of embryos of the grasses in the resting and germinating stages with those of other monocotyledons. He believed that the scutellum represented a cotyledon and that the epiblast was a reduced cotyledon. In another work[7] Kirbel regarded

[1] Opera omnia. 1687.
[2] De fructibus et seminibus plantarum. 1788.
[3] Genera plantarum secundum ordines naturales disposita. P. 28. 1789.
[4] Mémoire sur l'embryon des Graminées, des Cypéracées et du Nelumbo. 1808.
[5] Analyse des embryons Endorh. on. Monoc. et part de cel. d. Gr. 1808.
[6] Eléments de Physiologie végétable, r. I. 1809.
[7] Examen de la division des végétaux en Endorhizen et Exorhizes. 1810.

the plumule-sheath as belonging to the cotyledon, but in 1815 returned to his former view. Treviranus[1] opposed Richard's view and regarded the scutellum as a cotyledon. He speaks of the scutellum as enlarging itself the length of the seed and taking on a yellowish color, which is certainly not the case. Turpin[2] agreed with Mirbel that the embryo has two cotyledons. According to Cassini[3] the embryo of the grasses is composed of an axis, a cotyledon, one or two radicles, a plumule, and one or two "carnodes." His "cotyledon" is the plumule-sheath, while the "carnode," a name for the scutellum, he regards as a protuberance of the radicle. Raspail[4] compared the fruit and the flower. He believed that there was also an homology between the embryo and the culm. On examining the cotyledon he discovered a large nerve, joining the two nerves of the plumule-sheath at the base. From this he concluded that the scutellum is homologous to the peduncle of the aborted flower in the spikelet and to the sheath of the culm-leaf. He compared the plumule-sheath with the two-nerved palet in the spikelet and to the first leaf of the vegetative bud, and the endosperm to the flowering glumes of the spikelet and to bracts on the culm.

Dr. C. A. Agardh[5] in 1826 compared a longitudinal section of the embryo of *Ruppia* with the grass embryo and fruit, and found a great similarity between them. He regarded the entire endosperm of the grasses as the cotyledon, and the scutellum as a covering of the same. This, however, is impossible, as the scutellum never surrounds the endosperm. Bernhardi[6] believed that a cotyledon must, aside from its function of nourishment, also act as a protective organ to the young leaves. He therefore regarded the plumule-sheath as a cotyledonary-sheath and the scutellum as a cotyledon. Bischoff[7] also believed that the scutellum and epiblast are two cotyledons. He regarded the caryopsis as having an embryo with alternate cotyledons, without however giving any special grounds for this opinion. M. J. Schleiden[8] was the first to study the development of the grass embryo. According to him the scutellum and the plumule-sheath together form the cotyledon. He regards the epiblast as an outgrowth of the cotyledon, since it is connected with the main axis lower down than the cotyledon

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[1] Von der Entwickelung des Embryo und seiner Umhüllungen im Pflanzen-Ei. 1815.

[2] Mémoire sur l'inflorescence des Graminées. Ann. d. Mus. d'hist. Nat. 1819.

[3] L'analyse de l'embryon de Graminées, Jour. de Physique. T. 91. 1820.

[4] Sur la formation de l'embryon dans les Graminées. Ann. des Soc. Natur, Series 1, vol. 4, plates 13–14, 1824, 271–290. 1824.

[5] Über die Eintheilung der Pflanzen nach dem Cotyledon und besonders über den Samen der Monocotyledonen. 1 Nov. Act. C. B. C., T. XIII, P. I. 1856.

[6] Ueber der merkwürdigsten Verschiedenheiten des entwickelten Pflanzenembryo. Linnaea. 1832.

[7] Lehrbuch der Botanik I. 1834.

[8] Einige Blicke auf die Entwickelungsgeschichte des vegetale Organ bei den Phan., Wieg. Archiv. III, I. 1837.

itself. Adrien de Jussieu[1] differed from his father in the interpretation of the parts of the embryo, believing that the scutellum is not a true cotyledon but only a lateral appendage of the axis which resembles one. This view has been held by many up to the present time. Regel[2] considered the plumule-sheath the true cotyledon and the scutellum first as a stipule and again later as a bract from which the plumule arises laterally. In the same year Reisseck[3] advanced the opinion that the plumule-sheath is an axillary bud and that the cotyledon (Samenlappe) is an organ of the aborted terminal bud and the protecting leaf of the plumule, and that the epiblast is united with the cotyledonary-sheath, which is evidently also a part of the cotyledon. Lestiboudois[4] regarded the plumule-sheath as the cotyledon, but considered the scutellum of no significance, because only the former is traversed by fibrovascular bundles, hence resembling two leaves grown together.

Hofmeister[5] interpreted the embryo in different ways, describing the development of *Zea*. He called the scutellum the cotyledon and the plumule-sheath a part of it. A few years later, in another work,[6] he compared the so-called scutellum of the embryos of *Zea* and *Andropogon sorghum* with the first leafless structures of *Zostera*. Demoor[7] investigated a large number of the fruits of grasses in the mature stage, and also their development. He regarded the scutellum as the true cotyledon of the grasses, and the plumule-sheath not as representing the ligule, but as a sheath of a primordial leaf. This would not, however, correspond to the alternating arrangement of the leaves of grasses, a difficulty which he bridges over by citing that there is no opening of the sheath in *Melica uniflora* because of the growing together of the two margins of the leaf. He admits, however, that he has not been able to observe this. J. C. Agardh[8] speaks of the embryo as sometimes presenting a thalloid form. Schacht[9] considered the scutellum as the cotyledon, the plumule-sheath as the first leaf, and the epiblast a part of the cotyledon.

Hofmeister,[10] writing again concerning the grass embryo, stated: "I still regard the scutellum of the grasses and the analogous structure

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[1] Sur les embryons monocotylédones. Compt. Rend. des Soc. de l'Acad. des Sciences, **9**: 15–31. 1839.

[2] Beobachtungen über den Ursprung der Stipeln. Linnaea, 17. 1843.

[3] Monocotylischer Embryo. Bot. Zeit. 1843.

[4] Phyllotaxie anatomique, Ann. des. sc. naturelles, ser. III, **10**: 15. 1848.

[5] Die Entstehung des Embryo der Phanerogamen. 1849.

[6] Zur Entwickelungsgeschichte des Zostera embryo. 1852.

[7] Note sur l'embryon des Graminées. Bull. de l'Acad. roy. des Sci. de Brux. 1853.

[8] Theoria system. plant. 1858.

[9] Lehrbuch der Anatomie und Physiologie der Gewachse. 2, 1859 und das Mikroscope, 224. 1862.

[10] Neue Beitrage zur Kenntniss der Embryobildung der Phanerogamen Abhand. der königl. sachs. Gesellschaft. d. Wien. 1861.

of *Zostera* as an outgrowth from the axis, and not as a leaf." In this he agrees with Adr. de Jussieu. A. Gris,[1] studying the embryo of *Zea* from a physiological standpoint, also regarded the cotyledon as a lateral expansion of the axis, modified in such a manner as to become the principal absorbing organ of the embryo.

Duchartre[2] stated that the embryo is remarkable in having an oval, flat, or slightly curved, bud-like expansion at its base, called by Gaertner the "scutellum." This organ directly adjoins the endosperm by its dorsal face. In front of it is another shoot, which Richard calls the "blaste." Le Maout and Decaisne[3] regarded the scutellum as a cotyledon, which is often split along its outer face, showing the radicle and plumule. The plumule is conical and composed of one to four primary convolute leaves. They regarded the plumule sheath as the first leaf of the plumule. Sandeen[4] investigated a large number of ripe embryos and concluded that the scutellum is a thallus formation and that the plumule is a protuberance of the axis.

Sachs[5] regarded the scutellum as an outgrowth of the axis beneath the cotyledon and the plumule-sheath as the cotyledon, enveloping the whole plumule like a mantle. Hanstein[6] studied the development of *Brachypodium* from the embryo sac to its maturity. He regarded the scutellum as a leaf and a cotyledon, and both the plumule-sheath and the epiblast as trichomatic projections. This is difficult to imagine. Van Tieghem[7] reviewed the subject, illustrating the parts of the embryos of *Triticum æstivum*, *Hordeum vulgare*, *Avena sativa*, *Phalaris canariensis*, *Zea mays*, and *Andropogon sorghum vulgare*, briefly stating his own objections to the views previously held. He considered that the scutellum and plumule sheath together represent the cotyledon, which has at its opposite side a small protuberance called the lobule or epiblast. Owing to the presence of two vascular bundles in the plumule-sheath, he calls it a double stipule united at the margins, and homologizes the scutellum and plumule sheath with the leaf and ligule.

Hegelmaier[8] discussed the grass embryo from its developmental history, giving excellent figures of *Triticum æstivum*. He also noted the occurrence of secondary roots in *Coix*, *Hordeum*, *Secale*, *Avena*, *Triticum*, and other genera, concluding with Van Tieghem that the

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[1] Recherches anatomiques et physioloques sur la germin. Ann. des Sci. naturelles, ser. 5, **2**: 1864.

[2] Eléments de Botanique. 1867.

[3] Recherches anatomiques et physioloques sur le germin. Ann. des Sci. naturelles, ser. 5, **2**: 1864.

[4] Bidrag till kaenn ed omen om Grasembryots byggnad och Utweckling. Acta Univers, Lundens, 1868.

[5] Lehrbuch der Botanik, 474. 1868. Eng. Trans. and revision by S. H. Vines, 1882.

[6] Die Entwickelung des Keimes der Monocot. and Dicot. Botanis, Abhand, 47. 1870. Taf. 14, figs. 11–21; Taf. 15–18.

[7] Sur les Cotyledons des Graminées. Ann. des Sci. naturelles, series 5, **15**: 723–276. 1872.

[8] Zur Entwickelungsgeschichte monocotylischer Keime, etc. Bot. Zeit. 1874.

scutellum and plumule-sheath together correspond to the cotyledon of the other monocotyledons. A. Stephen Wilson[1] held that the cotyledon of the grasses had not yet been correctly interpreted, and that the morphological interpretation lay in whether the two vascular bundles of the plumule-sheath represent the middle nerves of two leaves or whether they only occur to strengthen the organ. In comparing this with the leaves in the terminal bud of the rhizome of *Agropyron repens* he found a difficulty, owing to the latter being many-nerved. He believed that the scutellum certainly has the function of a cotyledon and is a nourishing organ for the embryo at germination, but whether the plumule-sheath is also a nourishing organ is left in doubt.

Gordon[2] studied the morphology of the inflorescence. He says that the node-like swelling at the base of the plumule-sheath occurs very generally in the grasses. It appears to be a part of the node, but in reality is only a circular swelling at the base of the closed sheath. The proper node lies underneath this swelling. The plumule-sheath must exercise a certain pressure on the axis, and if axillary buds are present this pressure must have a certain influence on the plumule. The author speaks of the well-known organ, which denotes the origin of a branch, and which is looked upon by most morphologists as a two-keeled simple "Vorblatt" (prophyllum), with its back turned toward the main axis. The axillary shoots in *Zea*, *Tripsacum*, *Coix*, and many others make a cavity or groove in the culm, showing that they have developed under pressure of the sheath. The tissue at the base of the culm remains soft and capable of growth for a long time as a basal vegetation point. In other grasses, such as *Arundo* and *Phalaris*, the axillary shoot does not press itself into the culm. In these the growing point breaks through the sheath to the light. In *Arundinaria* the sheath soon dries up and the growing point has nothing to hinder it. Attempting an analogy between the fruit and the spikelet, he concluded that the plumule-sheath represents two leaves grown together. Certain *Gramineæ*, he says, have one or two buds in the axil of the plumule sheath, each with a prophyllum.

Warming[3] regards the scutellum as the cotyledon and the plumule-sheath as an independent leaf, the latter because an internode is occasionally found. Klebs[4] agrees with Van Tieghem. Hackel[5] believes, as does Warming, that the epiblast is a rudimentary second cotyledon.

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[1] On the envelope of the plumule in the grass-embryo. Trans. and Proc. of the Bot. Soc. of Edinburgh. **13**: 457. 1879 (with plate).

[2] Etudes morphologiques sur la famille des Graminees. Revue des Sci. naturelles, Montpellier. 1879.

[3] Handbog i den Systematiske Botanik. Trans. by Potter. 1895.

[4] Beitrage zur Morphologie und Biologie der Keimung. Untersuch aus d. Bot. Institut der Lubingen.

[5] Echte Graser. Engler und Prantl. Pflanzenfamilien, **2**: 1887. 2. Eng. Trans. by Scribner and Southworth. 1890.

Regarding it as a cotyledon explains the peculiar position of the first leaf over the scutellum. Many authors, he says, regard the plumule-sheath as a part of the cotyledon, surely an incorrect idea. Lermer and Holzner[1] in an exhaustive histological treatise on *Hordeum vulgare* describe in detail the different parts of the fruit. They regard the scutellum as a shield-like expansion of the hypocotyl, acting as a special absorption organ, and the plumule as composed of four leaves inclosed in a plumule-sheath, but attempt no interpretation of the latter view.

Bruns[2] has investigated the grass embryo chiefly from a systematic point of view. He describes and figures a large number of genera of each of the tribes. He regards the scutellum as one cotyledon, and the epiblast as a second, much reduced on account of the great development of the former. He considers it of no consequence from a systematic standpoint whether or not the scutellum and the epiblast are regarded as two cotyledons, provided it is granted that they represent two leaves, as the cotyledons are the first two leaves placed together. The plumule sheath is the thickened first leaf of the plumule especially adapted for protecting the young leaves. It has no blade, a common characteristic of the lower leaves of grasses. Schlickum,[3] in comparing the cotyledons of the monocotyledons, says that when the cotyledon has assimilating functions to perform its lamina displays a differentiation into a nutrient portion, the haustor, and a conducting portion, the conductor. In the grasses the conductor is very rudimentary or entirely suppressed, while the scutellum is transformed into the haustor, which bears no resemblance to a foliage leaf. The epiblast is probably an outgrowth of the coleorhiza. When the cotyledon does not emerge above the soil its function is to take up, by means of the haustor, the nutrient substances present in the endosperm, and to protect the rudimentary leaves by the formation of a more or less developed cotyledonary sheath.

Finally, Celakovsky[4] reviews the work of previous investigators and criticises them especially in regard to the homology of the epiblast and plumule-sheath. He believes that the true morphological nature of the parts can only be determined by investigating along many different lines, and if all these lines point toward the same conclusion, then surely it must be the correct one. The writer investigates the fruit according to the four following lines: (1) Ontogeny; (2) taxonomy; (3) anatomy; and (4) progressive and retrogressive metamorphoses. He then attempts to find out where the scutellum and plumule-sheath are joined at the base; where they separate; and whether the plumule-

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[1] Beitrage zur Kenntniss der Gerste. Munchen, 1886. Extract by Brown and Morris Chem. Soc. Jour., vol. 57. 1890.

[2] Der Grasembryo. Flora, 76: 1892.

[3] Morphologischer und anatomischer Vergleich der Cotyledon und ersten Keimblatter der Keimpflanzen der Monocotyledon. Bibl. botan. Heft. 35. 1896.

[4] Uber den Homologien der Grasembryo. Bot. Zeit., Sept. 1897.

sheath is inserted directly over the scutellum; and, finally, how the insertion of the plumule-sheath becomes separated so far from the scutellum through the elongation of the axis. He also homologizes the grass fruit with *Smilax*, *Potamogeton*, *Ficus elastica*, the mosses, and the leaf of the grasses. He regards the scutellum as the blade of the cotyledon, and as being homologous with the blade of the leaf. Over the scutellum is situated the plumule-sheath which is homologous to the ligule. The epiblast is the blade of an opposite second cotyledon.

SUMMARY.

The most important views of the different authors may be summed up as follows:

1. The scutellum is the cotyledon; the epiblast a second independent leaf; the plumule-sheath a third leaf; while the first true leaf is the fourth lateral appendage of the embryo.—(Malphigi, Mirbel, and Poiteau.)
2. The scutellum and the epiblast together form the cotyledon, the plumule sheath a second leaf, and the first true leaf becomes the third lateral appendage of the embryo.—(Schleiden, Shacht, and Decaisne.)
3. The plumule-sheath represents the cotyledon, the scutellum and epiblast being only expansions of the axis or of the radicle; and the first true leaf then becomes the second lateral appendage of the embryo.—(Richard, Adr. de Jussieu, Lestiboudois, Hofmeister, and Sachs.)
4. The scutellum is the central portion of the cotyledon, the epiblast an opposite appendage of it, and the plumule-sheath an ascending part in the form of a protective organ; the first true leaf then becomes the second lateral appendage of the embryo.—(Gaertner and Mirbel, at a certain time.)
5. The scutellum and the plumule-sheath together represent the cotyledon, and correspond to the blade and ligule of the culm-leaf; the epiblast is a protuberance of the cotyledon on the opposite side.—(Van Tieghem and Klebs.)
6. The sixth view is the same as the fifth, with the exception that the epiblast represents a second cotyledon opposite the scutellum.—(Celakovsky.)
7. The scutellum is one cotyledon and the epiblast is the other, the plumule-sheath being the first leaf of the plumule.—(Bruns.)

GENERAL DESCRIPTION OF THE FRUIT.

The embryo of grasses stands isolated from those of other monocotyledons in possessing two peculiar structures, the *epiblast* and plumule sheath. The following investigations were undertaken to determine the morphological significance and taxonomic value of these structures in the different tribes. Owing to the difficulties met with at the outset

in securing a suitable method, the work is not so complete as at first anticipated.[1]

The fruit of the *Gramineæ* was described first by Mirbel under the name "cerium" and rechristened later by Richard "caryopsis."

Its contents at maturity consist largely of endosperm and embryo, the tissues of the nucellus, ovule, and ovary being almost completely displaced. The only remnants of the nucellus which are recognizable in the ripe grain are the empty cells which spring from the funiculus, and the epidermis of the nucellus, which is continuous as a very attenuated layer of cells around both endosperm and embryo. Of the walls of the ovary only the inner one persists as a double layer of cells forming the testa or true coat of seed. Within the nucellus are one to four layers of cells with highly cuticularized walls. In section they are somewhat rectangular in form and constitute the gluten cells which contain the closely packed aleurone grains.

Lying between the starch-containing portions of the endosperm and the embryo is a comparatively thick layer of compressed cells belonging to the scutellum. They are for the purpose of dissolving the starchy material of the endosperm during germination. The endosperm consists of thin-walled cells packed closely with starch granules, embedded in a fine mass of proteid material. These starch-containing cells each possess a nucleus which is not easily recognized.

The embryo is situated laterally and at the base of the seed. It is differentiated into the scutellum, the plumule, the radicle, and frequently the epiblast. The plumule is surrounded by the plumule-sheath, which sometimes has a slit-shaped opening on the side opposite to that of the scutellum. The plumule sheath is composed of a vegetation point and several layers of leaves. The radicle is inclosed in the lower part of the embryo, and at germination, before making its exit, must break through a protective mass of tissue, the coleorhiza, so called because it forms a kind of sheath around the radicle. Secondary radicles frequently occur in the mature and resting embryo. They arise in the axis usually just below the plumule.

The vascular system may be traced down into the primary radicle, and also into the scutellum, plumule-sheath, and plumule.

THE SCUTELLUM.

The name "scutellum" has been given to the cotyledon of the grasses because of its resemblance to a little shield. It has for its object the protection of the plumule and the absorption of nutrient materials from the endosperm.

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[1] The author wishes to express his thanks to Prof. W. W. Rowlee for many helpful suggestions during the progress of the work; also to Profs. F. Lamson-Scribner and W. J. Beal for much valuable material, and to Prof. F. C. Harrison, of the Ontario Agricultural College, at Guelph, Canada, and to Messrs H. R. Carveth and O. Shantz for aid in the discovery of a method.

Observing a cross section of any embryo, one sees that the scutellum surrounds the plumule like a sheath. In *Zea* (figs. 4 A–F, Pl. I), *Andropogon* (figs. 10 A and B, Pl. II), and others the plumule is almost completely surrounded by the scutellum, so that only a narrow opening may be seen. A longitudinal section of *Andropogon saccharatus* (fig. 9, Pl. II) shows the scutellum so completely surrounding the plumule that it appears as if an epiblast was present. By observing a cross section, however, it is seen that the margins of the scutellum surround the plumule with the exception of a small slit (fig. 10 B, Pl. II). At a point toward the apex of the plumule sheath the scutellum bears a protuberance which projects over the plumule. This is especially distinct in *Lygeum* (fig. 25, Pl. IV), *Lolium* (fig. 75, Pl. VIII), and *Ammophila* (fig. 42, Pl. V). This part has been called the cotyledonary sheath (c. s.) to distinguish it from the plumule-sheath (pl. sh.).

At the base of the scutellum there is another protuberance in many embryos, such as *Avena* (fig. 44, Pl. V), *Triticum* (fig. 69, Pl. VII), *Anthoxanthum* (fig. 29, Pl. IV), *Uniola* (fig. 61, Pl. VII), *Bulbilis* (fig. 58, Pl. VI), and *Beckmannia* (fig. 60, Pl. VI). Sometimes a deep cleft occurs, appearing as a separation of the radicle. In some embryos the scutellum has a distinct sheath and a blade. A striking example of this may be seen in *Avena* (fig. 44, Pl. V), *Spartina* (fig. 53, Pl. VI), and *Zizania* (fig. 22, Pl. III).

The attachment of the scutellum to the axis varies considerably in different embryos. *Desmazeria* (fig. 63, Pl. VII) and *Anthoxanthum odoratum* (fig. 29, Pl. IV) have the attachment directly at the base of the plumule. In others there is a lengthening of the axis with the attachment at the base, leaving a very small proportion of the embryo to represent the hypocotyl: *Zizania* (fig. 22, Pl. III), *Homalocenchrus* (fig. 28, Pl. IV), and *Spartina gracilis* (fig. 53, Pl. VI).

The scutellum has at every point where it comes in contact with the endosperm a layer of peculiar oblong cells called the epithelial layer. Sachs regards it as corresponding to the somewhat similar layer found in the cotyledons of the palms, and to the young epidermis of *Ricinus* and many other seeds. The scutellum, therefore, may be regarded as part of the cotyledon.

THE EPIBLAST.

The peculiar organ, the epiblast of Richard, situated opposite to the scutellum, is not very well understood. Its occurrence in the *Gramineæ* is of much greater frequency than is generally supposed. Warming[1] describes the fruit of the grasses, but does not mention the epiblast. He figures a fruit of *Avena sativa*, but does not represent the epiblast, which is always present and quite distinct. Van Tieghem[2] speaks of the existence of a second cotyledon in a dozen or less of the genera of

[1] Warming and Potter. 1895.
[2] Comptes Rendus heb. Lean. l'Acad. des Sci. **124**: 1896 and 1897.

the *Gramineæ*. Unlike the scutellum, the epiblast has no vascular system, and on this account much dispute has arisen over its morphological nature. This, however, is no proof against its leaf nature, as there occur many instances of reduced organs without fibrovascular systems.

Although the epiblast is usually very small in comparison with the scutellum, yet there are many grasses in which it reaches a considerable size. *Zizania aquatica* (fig. 22, Pl. III) has a well-marked epiblast extending from the base of the lengthened axis to about the middle of the plumule, or even further.

In the genus *Stipa* there are marked differences in the size of the epiblast in the different species. *S. tenacissima* (fig. 30, Pl. IV) has a very small one; in *S. pennata* it is long and attenuated; while in *S. richardsoni* (fig. 36, Pl. V) and *S. viridula* (figs. 32 and 33, Pl. IV) it is very large and broad. Sometimes the margin of the epiblast is curved or deeply keeled, although in the large majority it is straight. *Homalocenchrus oryzoides* (fig. 28, Pl. IV) has a very large epiblast which greatly resembles the form of the scutellum. It is large and broad at the base and has a shield-like appearance. A small protuberance occurs at the base similar to that in the scutellum.

A fact which seems to indicate that the epiblast has the same morphological value as the scutellum is, that it is inserted on the axis almost at the same height. Even in *Zizania* (fig. 22, Pl. III), where the axis elongates to a great length and the insertion of the scutellum is almost at the base of the embryo, the epiblast is inserted directly opposite.

The absence or presence of the epiblast appears to be fairly constant in the different tribes, and the presence of an epiblast in a tribe where the majority of the genera have none may indicate that it is not in its natural position. The tribes *Andropogoneæ* and *Maydeæ*, to conclude from the genera examined, might be regarded as being without an epiblast. The scutellum almost entirely surrounds the embryo, as may be observed in any of the cross sections figured, more especially among the *Maydeæ*. In the tribe *Zoysieæ* there occur genera without an epiblast, as *Nazia*, *Trachys*, and *Anthephora*, while *Zoysia* has a distinct one. The *Tristegineæ*, to conclude from *Beckera* and *Arundinella*, have no epiblasts. The *Paniceæ* appear to be without an epiblast, the only exception being *Olyra*, which has a very large epiblast covering the plumule. From its great resemblance to the embryos of *Leersia* and *Oryza* it seems probable that it should be placed with them, or should form a separate intermediate tribe. The *Oryzeæ* appear to have a very large epiblast. The *Phalarideæ*, so far as examined, vary, *Anthoxanthum* and *Phalaris* having small epiblasts, while *Ehrharta* has none.

The *Agrostideæ* examined, although varying greatly in their external form, all possess an epiblast. In the large majority it is small, but in

some, as in *Stipa*, it is remarkably large, extending the whole length of the plumule. The *Aveneæ* also, so far as examined, all possess an epiblast. It is in the *Chlorideæ* that the most remarkable and varying formations of the embryo are to be found. *Eleusine* (fig. 52 A–D, Pl. VI) has a round nut-like fruit, with a small embryo having a very large epiblast; while *Spartina* (fig. 53, Pl. VI) has a long fruit, with the embryo extending almost the length of the seed, but with no trace of an epiblast. Between these occur the genera *Bulbilis* (fig. 58, Pl. VI), *Leptochloa* (fig. 56, Pl. VI), *Astrebla* (fig. 55, Pl. VI), *Cynodon* (fig. 57, Pl. VI), and *Beckmannia* (fig. 60, Pl. VI), each with an epiblast.

In the *Festuceæ*, a very large percentage of the genera have a well-formed epiblast, but in *Bromus* and some others it is absent. Among the *Hordeæ*, *Secale* (fig. 67, Pl. VII) and *Hordeum* (fig. 35, Pl. IV) are without an epiblast, while in *Lolium* (fig. 70, Pl. VIII) and *Triticum* (fig. 69, Pl. VII) it is present. *Elymus* (fig. 72, Pl. VIII) has a very light projection at the point where the epiblast is usually situated, and might be regarded as a transition stage between those with and those without an epiblast.

Among the *Bambuseæ* only the genera *Arundinaria* (figs. 74, 75, 76, Pl. VIII) and *Bambusa* have been examined. They possess very large broad epiblasts.

It appears, therefore, in most cases that the tribes *Maydeæ*, *Andropogoneæ*, *Zoysieæ*, *Tristegineæ*, and *Paniceæ* are without epiblasts, while in the *Oryzeæ*, *Phalarideæ*, *Aveneæ*, *Chlorideæ*, *Hordeæ*, *Festuceæ*, and perhaps, the *Bambuseæ*, it is usually present.

The following table will show that it is not correct to regard the epiblast as usually wanting in the Gramineæ.

Without epiblast.	*With epiblast.*
MAYDEÆ.	
Euchlaena.	
Zea.	
Coix.	
Tripsacum.	
ANDROPOGONEÆ.	
*Saccharum.[1]	
Andropogon.	
*SORGHUM.	
*Erianthus.	
Apluda	
ZOYSIEÆ.	
Perotis.	Zoysia.
* Trachys.	Nazia.
Anthephora.	

[1] The genera starred (*) are taken from Bruns's work, not examined by the writer.

RISTEGINEÆ.

* Arundinella.
* Beckera.

PANICEÆ.

Paspalum.
Pennisetum.
Chætochloa.
* Panicum.
Tricholæna.
* Pennisetum.
* Berchtoldia (Chaetium).
Cenchrus.

ORYZEÆ.

Oryza.
Zizania.
Homalocenchrus.
Lygeum.
Pharus.[2]

PHALARIDEÆ.

* Ehrharta.

Phalaris.
Anthoxanthum.
Savastana.

AGROSTIDEÆ.

Stipa.
Phleum.
* Polypogon.
Sporobolus.
* Piptatherum.
Calamagrostis.
Eriocoma.
Oryzopsis.
Brachyelytrum.
Ammophila.
Milium.
Chæturus.
* Apera.
Lagurus.
* Aristida.
Cinna.

AVENEÆ.

Avena.
Arrhenatherum.
Danthonia.
Aira.
Holcus.

[2] Van Tieghem. Ann. Sci. nat. Ser. 5, **15**: 240.

CHLORIDEÆ.

Spartina.	Leptochloa.
	Eleusine.
	Chloris.
	Beckmannia.
	Cynodon.
	Astrebla.
	Bulbilis.

HORDEÆ.

Secale.	* Nardus.
Hordeum.	Lolium.
Asperella.	Triticum.
	* Aegilops.
	* Lepturus.
	Elymus.

FESTUCACEÆ.

* Boissiera.	* Echinaria.
* Schismus.	Cynosurus.
Bromus.	Festuca.
Gynerium.	Leptochloa.
	Melica.
	Koeleria.
	Korycarpus.
	Desmazeria.
	Dactylis.
	Poa.
	Panicularia.
	* Lamarkia.
	* Avellinia.
	Briza.
	* Brachypodium.
	Triodia.

BAMBUSEÆ.

	Arundinaria.
	* Bambusa.

THE PLUMULE-SHEATH.

This peculiar structure is found in all grasses, completely surrounding and protecting the plumule, with the exception of a small opening or slit toward the apex on the side opposite to the scutellum. At germination the young leaves break through this sheath, which soon afterwards dies down. The plumule-sheath always has two distinct vascular bundles situated laterally and slightly inclined toward the scutellum. Considerable controversy has arisen as to whether this organ is a part of the cotyledon or whether it represents the first true leaf of the embryo. This will be treated of later under the chapter on the homology of the parts. It usually originates directly under the plumule and close to the insertion of the scutellum, although it is

widely separated from the scutellum in many grasses. See *Zizania* and *Homalocenchrus* (figs. 22 and 28, Pls. III and IV). Because of its thickness, it is specially adapted for a protective organ.

THE ROOT SYSTEM.

The large majority of the embryos of grasses have only one radicle, situated at the base of the embryo, usually in a vertical position, but sometimes turned obliquely, as in *Oryzopsis* (fig. 38A, Pl. V) and *Stipa richardsonii* (fig. 36, Pl. V), or, again, completely horizontal, as in *Eriocoma* (fig. 34, Pl. IV), *Oryza sativa* (fig. 27, Pl. IV), and *Eleusine* (fig. 52A–D, Pl. VI). In *Homalocenchrus oryzoides* (fig. 28, Pl. IV) it has a slightly upward tendency.

There are, however, embryos with numerous lateral roots. *Triticum æstivum* (fig. 69, Pl. VII) has four lateral roots, two on each side of the scutellum. *Zizania* (fig. 24O–Q, Pl. III) has three, situated directly under the plumule, a long distance from the main radicle. *Coix* (fig. 1, Pl. I) has four radicles, obliquely one above the other on the axis. In the illustration only three are seen, as they are not all in the same plane. *Hordeum vulgare* (figs. 65, 66, G and H, Pl. VII) has eight secondary radicles, three on each side of the scutellum and two in front. On germination the primary radicle is soon outstripped in growth by the secondary ones. Both the primary and secondary ones are surrounded by a compact mass of cells which form the coleorhiza or root-sheath.

Each radicle terminates in a rootcap, the cells of which appear as regular continuations of the rows of cells in the radicle. The rootcap can thus be distinguished from the coleorhiza, in which the cells are very irregular. The rootcap is not connected with the coleorhiza. The former is produced from the embryonic tissue, while the latter is derived from the preembryonic tissue and is connected with the lower part of the scutellum. In dissecting out the embryo the radicle or radicles, with their rootcaps, easily separate from the coleorhiza, leaving the latter at the base of the sockets in the lower part of the scutellum.

LATERAL BUDS.

In a number of genera of the tribe *Hordeæ* there is a lateral bud in the axil of the plumule-sheath: *Hordeum* (fig. 65, Pl. VII), *Triticum* (fig. 69, Pl. VII), *Elymus* (fig. 72, Pl. VIII), and *Secale* (fig. 67, Pl. VII). Bruns regards this as proving that the plumule-sheath must represent a leaf. Similar buds, however, may be found in Polygonum, Rumex, and a large number of plants with axillary stipules. Van Tieghem describes and figures lateral buds in *Avena sativa*, but it was not possible, after making many paraffin sections through different embryos, to discover them. This circumstance is remarkable in that *Avena* belongs to the tribe *Aveneæ*, while all other genera in which lateral buds have been found belong to the tribe *Hordeæ*. Bruns, however, figures and describes a *Bambusa* with a large lateral bud in the axil of the plumule-sheath.

THE FIBRO-VASCULAR SYSTEM.

The fibro-vascular system of the embryos of the *Gramineæ* may be considered under three main divisions, according to the manner and place of insertion of the plumule-sheath on the axis and its connection with the scutellum.

1. The plumule-sheath is inserted on the axis directly above the insertion of the scutellum: *Stipa* (fig. 36, Pl. V), *Phleum* (fig. 41, Pl. V), *Ammophila* (Fig. 42, Pl. V), and perhaps all of the *Agrostideæ*.

An example of this modification occurs in *Stipa viridula* (figs. 32 and 33, Pl. IV). A vascular bundle passes through the entire length of the scutellum. At the insertion of this bundle on the axis two branches are sent off from it which traverse the plumule-sheath (fig. 33, Pl. IV), while the main branch continues into the axis and then descends to the radicle. A little above this insertion numerous small bundles form and run up into the young leaves and vegetation point. As these different bundles are not all in the same plane, it is not possible to obtain a single section showing them. In any transverse section of the plumule, however, the bundles of the plumule-sheath may be seen quite distinctly.

In *Eriocoma cuspidata* (fig. 34, Pl. IV) the bundles ascend from the axis into the plumule-sheath, while in a cross section of *Stipa richardsoni* (fig. 37B, Pl. V), taken below the insertion of the scutellum on the axis, the vascular bundle may be seen entering the radicle. Again, in *Triticum* (fig. 69, Pl. VII) a bundle may be seen entering the first true leaf. *Hordeum* (fig. 65, Pl. VII) shows the bundles passing up into the second true leaf and the vegetation point, while several may be seen branching off from the axis into the secondary radicles. All the genera of the tribes *Agrostideæ* and *Hordeæ*, so far as examined, have this arrangement of their vascular systems.

2. The plumule-sheath is inserted on the axis at some distance from that of the scutellum, with which it is connected by a vascular bundle traversing the axis: *Zizania* (fig. 22, Pl. III) and *Homalocenchrus* (fig. 28, Pl. IV). The embryo of *Zizania aquatica* (figs. 22, 23 A and B, 24 A–T, Pl. III) has a remarkably long axis, which separates the insertion of the plumule-sheath and the scutellum to a very considerable degree. It will be noticed in the longitudinal section (fig. 22, Pl. III) that two vascular bundles traverse the axis, one terminating in the main radicle, while the other curves sharply round and traverses the long linear scutellum. The exceedingly large epiblast is devoid of any vascular system. In the transverse sections (fig. 24 A–T, Pl. III) it is found that in A, a section taken through the apex of the plumule-sheath, the two bundles have joined into one. In B they are beginning to separate, while in C and D they are entirely free. Figure E shows a section through the tip of the first leaf of the plumule, the plumule-sheath with its two widely separated lateral bundles surrounding it. Figures F–L illustrate sections taken through the plumule at different heights, showing the arrangement of the leaves with their bundles. The bundle in

the center of the leaf is always a little larger than the lateral ones. The bundle of the scutellum now appears distinctly in all sections taken through the region of the plumule. N represents a section taken directly underneath the plumule-sheath. The bundles of the sheath have united with those of the leaves and appear very irregular, with a secondary radicle appearing on each side. A little lower down a third secondary radicle is seen on the side of the axis next to the scutellum. The axis now for a considerable distance presents the appearance shown in P and Q, with two distinct, separate, vascular bundles in the center. At the base of the long axis one of these bundles situated nearest to the scutellum joins with the bundle of the latter, as in S, while the other continues down into the main radicle, as in T. This seems to prove conclusively that the plumule-sheath is not an independent leaf, but that it belongs to the scutellum.

There is no difference between this group and the first, represented by the *Agrostideæ*, except that between the insertion of the plumule-sheath and the scutellum there occurs a very long axis representing the first node.

3. The plumule-sheath is inserted on the axis at the base of the plumule, but its fibro-vascular bundles are not directly connected with that of the scutellum: *Zea*, *Coix*, *Pennisetum*, *Paspalum*, *Panicum*, and *Spartina*. *Zea mays* may be taken as typical of this arrangement of the vascular system, as shown by a series of sections from the radicle to the plumule (figs. 3, and 4 A–F, Pl. I). Fig. 4 A represents a cross section through the main, radicle. There are two systems of vessels, consisting of six large ones toward the center and about sixteen smaller ones on the outside, which, along with their conjunctive tissue, make up the central cylinder. Section B, taken somewhat higher up, above the region of coleorhiza shows the axis with its bundles beginning to form round the periphery of the central cylinder, the two systems of vessels remaining the same as in the radicle. The dark portions of the scutellum are sections through the lateral branches of the scutellum bundle. These peripheral bundles widen and come closer and closer to the center until they reach the condition figured in C, where there is an irregular mass of vascular strands and bundles with only a few of the vessels. Immediately above this the bundles arrange themselves round the periphery, leaving only a few in the center, while a vascular strand branches off and penetrates through the cortical parenchyma into the scutellum, where it divides into an ascending and descending branch, as in D. The large vessels have returned to their original position, while the smaller ones have become fewer, and are arranged irregularly nearer the center. At E, a section taken through the upper part of the scutellum, two radicles emerge from the axis to the right. Vascular bundles are found both in the periphery and in the center of the cylinder. The axis now continues in a regular form with its two systems of vessels and bundles arranged in the periphery,

until just below the plumule, where several bundles in the periphery unite on either side and branch off into the plumule-sheath. Soon numerous, bundles form in the center, until the whole axis is completely filled with them. These arrange themselves in a definite manner and run up into the leaves of the plumule.

There is no direct connection between the vascular bundle of the scutellum and those of the plumule-sheath, both originating from the peripheral bundles of the axis separately. The same condition occurs in all the genera of the *Maydeæ*, *Chlorideæ*, *Paniceæ*, and *Andropogoneæ* examined, with slight modifications as to the number and size of the vessels and bundles. This would seem to indicate that these tribes are closely related to one another, although it is not exactly in accordance with Hackel's classification of the tribes with reference to the *Chlorideæ*.

HOMOLOGY OF THE PARTS OF THE EMBRYO.

To what do the scutellum, epiblast, and plumule-sheath correspond; from what have they been developed; and to what parts of the leaf and spikelet of the grasses are they homologous?

The scutellum is at present generally regarded as the cotyledon, corresponding to the single cotyledon characteristic of the group of monocotyledons, but differing from them in not emerging from the caryopsis at germination.

The epiblast has been regarded in various ways by different authors. Bernhardi, Schleiden, Schacht, and, later, Van Tieghem, regard the epiblast as part of the cotyledon. Hanstein concludes that it is merely an insignificant trichomatic projection of the hypocotyl. The majority of writers, however, with Poiteau, Mirbel, and Bruns, regard it as a second rudimentary cotyledon, and in embryos in which it is wanting, look upon it as having become completely aborted.

Van Tieghem[1] in his new classification of the phanerogams based upon the ovule, revised his opinion concerning the epiblast, regarding it as a second rudimentary cotyledon, and explaining its partial or complete abortion as due to the pressure more or less exerted by the seed coat or pericarp upon the embryo. From this and other characters of the integuments and ovules he is led to believe that the *Gramineæ* are in reality dicotyledons, which have accidentally become monocotyledons.

In spite of the fact that there has never been found the slightest trace of a vascular system in the epiblast, yet it seems most reasonable to regard it as a second rudimentary cotyledon. One inclines to this view from the study of the perfectly developed epiblasts of *Homalocenchrus*, *Zizania*, and *Oryza*, where they are inserted on the axis opposite the insertion of the scutellum.

[1] Comptes Rendus seanc. l'acad. des Sciences, **124**: 1896–97.

The plumule-sheath is, of all the organs of the embryo, the most striking and difficult to explain. Three very different theories are held regarding its interpretation. To the first we attach the names of Hofmeister and Sachs, who regard it as an outgrowth of the so-called hypocotyledonary internode.

The adherents of the second view regard it as an independent leaf belonging to the plumule and next in leaf arrangement to the scutellum. According to this the plumule-sheath, which is directly above the scutellum on the same side of the axis, would not correspond to the distichous arrangement of grass leaves; but if one regards the epiblast as a leaf, i. e., a second cotyledon, then the apparent disagreement is explained and the plumule-sheath becomes the third leaf alternating with the epiblast. Bruns, who is a strong advocate of this view, sees no reason why Hanstein should deny the independent nature of the plumule-sheath because of its origin.

Let us briefly follow the devolopment of *Brachypodium* according to Hanstein's investigations. The young embryo is at first a spherical mass composed of three with sometimes a fourth smaller cell. These cells divide several times in all directions and the embryo takes on a club-shaped form, becoming longer and narrower at the base. This many-celled body is at this time without distinct internal or external differentiation. The lower-most cell, which has now become considerably divided, later goes to form the suspensor, while the two upper cells form the embryo proper. Soon the internal differentiation of the radicle can be seen with its dermatogen, periblem, and plerome. The second stage of development takes place in the external part of the embryo. In the wall there occurs a depression which marks the division of the scutellum from the hypocotyledonary part. The tissue immediately above this depression is the cotyledon, from which a part of the plumule-sheath soon emerges, while that on the lower side forms the vegetation point with its later-developed leaves. The projection on the upper part of the embryo, i. e., on the upper side of the depression, shows again on its upper surface another depression similar to the first, thus forming a second projection. At the same time a projection in the form of a half collar has formed on the lower part below the vegetation point. These two projections stand opposite one another like lips. Finally they grow and their margins unite to form a complete cap over the plumule. The occurrence of a slit in the mature plumule-sheath is in all probability caused by the incomplete junction of the margins of these collar-shaped projections. The tissue above this second depression, which sometimes curves down to a considerable degree protecting the plumule, forms that part of the cotyledon known as the cotyledonary-sheath. Thus the origin of the plumule-sheath indicates that it must be a part of the scutellum. To regard the plumule-sheath as an independent leaf as Bruns has done, one must look upon it as arising from a stem and not from a primordial leaf, which, according to Hanstein's investigations, is evidently the case.

The third view is that the plumule-sheath is a ligule-like growth proceeding from the scutellum as an inseparable part. The existence of an intermediate part between the insertion of the plumule-sheath and that of the scutellum in many embryos, is relied upon by Bernhardi, Bruns and others as positive proof that there can be no connection between these organs. By many authors it has been called an internode, which latter always develops between two leaves and not between two parts of a leaf.

Bruns says that while in *Euchlæna* the two insertion points are near together, it hardly seems plausible in the case of *Spartina*, and especially of *Zizania*, to regard two organs which are so widely separated from one another as the same. The occurrence of a bud in the axil of the plumule-sheath also influences his conclusion that the plumule-sheath must represent a leaf.

From a careful study of the vascular system of the different tribes, together with Hanstein's investigations, one is led to believe with Van Tieghem and Celakovsky that the so-called internode between the plumule-sheath and the scutellum, occurring so distinctly in *Zizania* and *Homaloceuchrus*, and not at all in the genera of the *Agrostideæ*, is nothing but the first unusually lengthened node. The ligule-like growth, the plumule-sheath, is usually inserted directly over the scutellum and the plumule-sheath in the mature fruits of *Zizania*, *Homaloceuchrus*, and the *Chlorideæ*, or as in *Oryza* (according to Bruns and Schlickum) soon after germination.

The vegetative leaf of the grasses is composed of a sheath and blade and a more or less strongly developed ligule inserted at the point of junction of the sheath and blade. The ligule is usually small, without chlorophyll and stomata, and exclusively parenchymatous, but as Duval-Jouve[1] has shown in *Ammophila arenaria*, it attains a length of about 4 centimeters and possesses nerves with chlorophyll and stomata. The ligule thus represents a double sheathing axillary stipule.

Of the three parts of the leaf it is the sheath which develops last, by an intercalary growth, which raises up the blade and ligule.

Comparing the culm leaf with the scutellum and plumule-sheath, the cotyledonary leaf of the embryo, one finds that the latter has no sheath. Its sessile blade, however, elongates to form the scutellum, while the pumule-sheath, which is homologous with the ligule, attains a great size with vascular bundles similar to the ligule of *Ammophila arenaria*. It is provided with two prominent lateral nerves, which later acquire chlorophyll and stomata.

The homology of the parts may in the same manner be carried out in the spikelet. The awn of the floral glume, when present, is regarded as corresponding to the blade of the leaf, and therefore to the scutellum of the embryo. When the awn is inserted on the back of the

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[1] Anatomie de l'arete des Graminees Mem. de l'ac. des Sci. et lettres. Montpellier. 1871.

glume some distance from the apex, that part between the insertion and the apex is regarded as corresponding to the ligule, and, in consequence, to the plumule-sheath. That part of the glume below the insertion of the awn is regarded as the sheath of the leaf, while its analogous structure in the embryo has been arrested in its development.

Colomb,[1] who has investigated the stipules of many plants, also takes up the ligule and sees in it an analogy to the stipules of *Potamogeton* and *Smilax*. Celakovsky[2] makes a comparison between these, adding another plant, *Ficus elastica*. He carries his homology still further to the mosses, believing that the moss capsule is homologous to the cotyledon and the seta or their bases to the hypocotyl.

DETAILED DESCRIPTIONS OF FRUITS.

Tribe MAYDEÆ.

The fruits of the genera of this tribe are large, ellipsoidal or roundish, and inclosed, with the exception of *Zea*, in a hard capsule formed of the glumes or of part of the articulate rachis. They have a very large embryo, with the scutellum almost completely surrounding the plumule.

Coix lachrymæ-jobi L. (figs. 1, 2 A–G, Pl. I). The structure of the embryo of *Coix* resembles that of *Zea mays*, the main difference consisting in the former possessing four lateral radicles. Only three are shown in fig. 1, the fourth and uppermost one not being in the same plane. Fig. 2 A represents a transverse section through the upper part of the plumule, showing the plumule-sheath with its two bundles and the first and second true leaves in their normal position. A section through the base of the plumule (fig. 2 B) shows the plumule-sheath and a small part of the first, true leaf. Within is the axis with its numerous bundles which belong to the leaves of the plumule.

At C is the axis, with its numerous bundles and the plumule-sheath. Some of the bundles in the periphery of the central cylinder unite and branch off into the plumule-sheath on each side. A little lower down, between the insertion of the plumule-sheath and that of the scutellum the axis appears with its numerous bundles arranged in the periphery of the central cylinder (fig. 2 D). Fig. 2 E shows the scutellum inserted on the axis by its broad, fibrovascular bundle, at the same time cutting through the first lateral radicle on the opposite side. A number of ducts are scattered here and there in the axis. The axis terminates in the lowermost radicle, the central cylinder having six distinct ducts or vessels. Fig. 2 F shows a section through the upper part of the lowermost radicle and one of the lateral radicles, while G represents a section through the lowermost radicle. Each radicle is provided with a root-cap while the coleorhiza surrounds them all. The

[1] Recherches sur les stipules. Ann. des Sci. nat. Ser. 6, 1: 19. 1887.

[2] Ueber die Homologien des Grasembryo. Bot. Zeit., Sept., 1897.

scutellum entirely surrounds the remainder of the embryo, as may be seen in cross section or in the longitudinal section (fig. 1). There does not appear to be such a direct connection between the vascular bundle of the scutellum and those of the plumule-sheath, as in *Zizania* (fig. 22, Pl. III), *Homalocenchrus* (fig. 28, Pl. IV), and other embryos. The vascular bundle of the scutellum, as in the other genera of the *Maydeæ*, branches into two, one traversing the upper and the other the lower part of the scutellum, and these again sending off lateral branches. The leaves of the plumule are arranged as in all grass embryos.

Zea mays L. (figs. 3, 4 A–F, Pl. I).—The vascular system of *Zea* has already been described. The general structure of the embryo differs but little from that of *Coix*. Instead of four large lateral radicles it has one large main radicle (fig. 4 A) and two smaller secondary ones at the insertion of the scutellum bundle on the axis. The scutellum surrounds the remainder of the embryo like a mantle, the margins almost coming together, but separated by a long, narrow groove (figs. D and E). There is a deep cleft between the base of the scutellum and the coleorhiza (fig. 3).

Tripsacum dactyloides L. (figs. 5, 6, 7, A–B, Pl. I).—The embryo of *Tripsacum* is very similar to that of *Zea* and *Coix*, except that it has only one radicle. The axis is remarkably long and consists of a number of vascular bundles, as in *Coix*. About halfway down the axis the bundles in the periphery increase toward the center, presenting the same condition as in *Coix* and *Zea*, again returning to the periphery and disappearing as they approach the radicle. The insertion of the scutellum-bundle is not as in *Coix*, *Zea*, and *Euchlæna* at some distance from the plumule but directly under it, where the plumule-sheath also branches off (fig. 6). The scutellum-bundle soon after leaving the axis divides, one branch traversing the lower, and the other the upper part of the scutellum, while these in turn have lateral branches (fig. 6). Aside from these bundles connected with the vascular system there are conducting vessels running irregularly through the scutellum, apparently nourishing organs for the plumule and radicle, as they can be traced to be directly connected through the epithelial layer with the other parts of the embryo (fig. 6).

Euchlæna mexicana Schrad. (fig. 8, Pl. II).—The structure of the embryo of *Euchlæna* is almost identical with that of *Zea mays*, except that it has no secondary radicles and the insertion of the scutellum-bundle is at some distance from the plumule.

Tribe ANDROPOGONEÆ.

The fruits of the tribe *Andropogoneæ* have an embryo which is usually about half the size of the fruit itself. As in the *Maydeæ*, the scutellum almost completely surrounds the remainder of the embryo. By comparing the embryo of *Andropogon* (fig. 9, Pl. II) with *Zea* (fig. 3, Pl. I) one notices a striking similarity. The scutellum-bundle is inserted on

the axis at some distance from the plumule, as in the majority of the *Maydeæ*.

Andropogon saccharatus (fig. 9, 10, A–C Pl. II).—The scutellum almost surrounds the plumule. The projection appearing in fig. 9 like an epiblast is only a longitudinal section through one of the margins of the scutellum. The scutellum-bundle is inserted on the axis at some distance from the plumule, while directly under the plumule two bundles branch off into the plumule-sheath. Fig. 10 A shows a section through the plumule with its plumule-sheath and bundles of the first true leaf, while fig. 10 B represents a section taken through the axis between the plumule and the insertion of the scutellum-bundle. Only one radicle is present with a large vessel in the center and five smaller ones around it in the central cylinder (fig. 10 C). There is a deep groove between the scutellum and the coleorhiza.

Apluda cristata (figs. 11, 12, Pl. II).—The embryo of *Apluda cristata* resembles those of the *Maydeæ* and *Chlorideæ*. There is no epiblast. The radicle appears as in fig. 12, with one large vessel and six smaller ones in the central cylinder. This arrangement continues through the axis until near the insertion of the scutellum, where vascular bundles appear. These continue through the lengthened node as far as the base of the plumule, where they send off branches into the plumule-sheath. The ring around the radicle in fig. 12 represents a cross section through the coleorhiza.

Tribe ZOYSIEÆ.

The *Zoysieæ* resemble on the one hand the *Andropogoneæ*, through *Trachys*, *Anthephora* (fig. 13 A–E, 1 Pl. II), and *Perotis* (fig. 15 A–D), and on the other hand *Oryzeæ* through *Zoysia* (fig. 14 A–D) and *Nazia*. Bruns, in a list of genera, represents *Nazia* without an epiblast, while in his figures he represents it with an epiblast, both in longitudinal and transverse sections. The scutellum in *Anthephora* and *Perotis* is inserted at some distance from the plumule, while in *Zoysia* it is inserted directly under it. The radicle of *Zoysia* is also curved in a horizontal direction like *Oryza*.

Tribe TRISTEGINEÆ.

Unfortunately no representatives of this tribe could be secured. Bruns, however, who has investigated the fruits of *Beckera* and *Arundinella*, found them to be without an epiblast, and similar to the *Zoysieæ*.

Tribe PANICEÆ.

The general appearance of the fruits of the *Paniceæ* is similar to those of *Andropogoneæ*. They are, with one exception, without an epiblast, and have the scutellum-bundle inserted at some distance from the plumule. *Olyra* is the only genus which has an epiblast. It is

described and figured by Bruns, and differs in every respect from the other *Paniceæ*. The scutellum is broader than long, while the plumule is covered by a very large epiblast. A peculiarity mentioned by Bruns is that the radicle is hollowed out. Owing to the general appearance of the fruit and embryo, with its large epiblast and the insertion of the scutellum-bundle, also the fact that the flower is monœcious, would seem to indicate that it does not belong to the *Paniceæ*. It might, perhaps, be placed with the *Oryzeæ* or form an intermediate tribe with *Zoysia* between the *Paniceæ* and *Oryzeæ*.

Pennisetum spicatum (figs. 16, 17, 18, Pl. II).—The fruit of *Pennisetum* has a very large embryo. The scutellum surrounds the remainder of the embryo, although not to such an extent as in the *Andropogoneæ* and *Maydeæ*. The projection opposite the scutellum in fig. 16 is not an epiblast, but a longitudinal section through the margin of the scutellum. A single large radicle is present, which consists of one large vessel in the center and six small ones surrounding it in the central cylinder (fig. 18). The ring around the radicle represents the coleorhiza with its attachment to the scutellum. Fig. 17 represents a cross section through the plumule, showing the scutellum with its bundle and the plumule-sheath with its two lateral bundles. Within is the first true leaf. The scutellum-bundle is inserted on the axis at some distance from the plumule (fig. 18).

Chætochloa macrochæta (fig. 19, Pl. III).—The embryo of this nut-like fruit resembles in the main other *Paniceæ*. The insertion of the scutellum-bundle is, however, somewhat closer to the plumule. A deep cleft or groove is present between the scutellum and coleorhiza.

Paspalum pubiflorum glabrum (figs. 20, 21, Pl. III).—The embryo of *Paspalum* resembles that of *Pennisetum*, although much smaller. It possesses a large radicle, and its scutellum-bundle is inserted at some distance from the plumule.

Tribe ORYZEÆ.

To this tribe belong, among others, the genera *Homalocenchrus*, *Zizania*, and *Oryza*. Great variation occurs in the size and formation of the fruits. The embryo is usually small compared with the amount of endosperm, but in *Zizania* it attains a considerable size. All the genera belonging to this tribe have a well-marked epiblast.

Zizania aquatica (figs. 22, 23 A–B, 24 A–T, Pl. III) (see p. 21).—The fruit of *Zizania* is long and linear, with an epiblast which reaches three-quarters the length of the whole fruit. Figs 23 A and B show the relative size of embryo and endosperm; A through the plumule, and B through the axis or lengthened node. Figs. 24 A–T represent a series of sections through the embryo from the apex of the plumule-sheath to the main radicle. A and B show the two vascular bundles of the plumule-sheath, which at this point are united into one. At C and D they have become separated, while at E the plumule-sheath appears as

a complete ring, inclosing the upper part of the first leaf. The opening in the plumule-sheath on the side opposite to the scutellum now appears for a short distance as shown at G. At H, I, and J it is again closed, and within is seen the arrangement of the leaves of the plumule. K shows the first appearance of the epiblast, while at M it has increased in size. Within the plumule-sheath and first leaf one sees the axis with its bundles which belong to the remaining leaves of the plumule. Immediately below the plumule are three secondary radicles represented in N and O. The embryo for a considerable distance presents a form similar to that shown at P. The vascular system in the region of the secondary radicles presents a confused mass, but here it consists of two regular strands which course the lengthened node. As they approach the insertion of the scutellum the inner one becomes larger until it unites with the bundle of the scutellum. R shows the attachment of the epiblast to the axis, the division being marked by a dotted line, while T is a section through the main radicle surrounded by its coleorhiza.

Homalocenchrus oryzoides (fig. 28, Pl. IV).—The fruits of *Homalocenchrus*, although much smaller and of a different form from that of *Zizania*, yet in the main possess the same structural characters of the embryo.

Lygeum spartum (figs. 25, 26 A–E, Pl. IV).—The embryo of *Lygeum* differs from the other genera of the *Oryzeæ* examined in having a very small epiblast. The insertion of the scutellum-bundle occurs directly beneath the plumule. Also at this point branches are sent off into the plumule-sheath (fig. 26 B). The radicle is here lengthened out to a considerable extent. Lateral roots also arise from the node, as in fig. 26 C and D. Fig. 26 E shows a section through the main radicle, while 26 C shows parts of the secondary radicles and the base of the epiblast.

Oryza sativa (fig. 27, Pl. IV).—Compared with the amount of endosperm, *Oryza* has a very small embryo. The epiblast is large and broad at the base. As in *Lygeum*, the insertion of the scutellum is at the base of the plumule. The large radicle is directed obliquely outward.

Tribe PHALARIDEÆ.

Of the *Phalarideæ* only *Phalaris* and *Anthoxanthum* (fig. 29, Pl. IV) were examined. These much resemble the *Agrostideæ*, having a small epiblast and a straight radicle. The scutellum-bundle is inserted at the base of the plumule-sheath.

Tribe AGROSTIDEÆ.

The *Agrostideæ* may be characterized as fruits with small embryos, always with an epiblast, which, however, varies greatly in size. The scutellum-bundle is inserted on the axis at the base of the plumule. Here it branches to the right and left, running up into the plumule-

sheath. The short axis terminates in a single radicle. Among the peculiarities noticed in this tribe is the genus *Stipa*. *Stipa pennata* has a well-marked epiblast more than half the length of the plumule, while *S. tenacissima* (figs. 30 and 31, Pl. IV) has a very small epiblast. In fig. 31 the opening of the plumule-sheath is apparent. In *Stipa richardsoni* (figs. 36 and 37 A and B, Pl. V) the epiblast extends more than half the length of the plumule, and the radicle is directed obliquely outward. Although *S. viridula* (figs. 32 and 33, Pl. IV) has a very small fruit, yet its embryo has proportionately the largest epiblast.

Eriocoma cuspidata (figs. 34 and 35, Pl. IV).—The fruit of *Eriocoma* resembles that of *Oryzopsis*, but has a very large epiblast which extends the whole length of the plumule. The scutellum differs from *Oryzopsis* in having a groove at its base. This character, together with the long, densely hairy, flowering glumes, would warrant its being placed as a separate genus *Eriocoma*, which is regarded as a subgenus by Hackel.

Oryzopsis micrantha (figs. 38 A and B, Pl. V), *Phleum pratense* (fig. 41, Pl. V), *Cinna arundinacea* (figs. 39 and 40, Pl. V), and *Brachyelytrum erectum* (fig. 43, Pl. V) all have a well-marked epiblast. The last named can easily be recognized by a long, pointed projection proceeding from the pericarp. This projection contains no starch, and its presence is remarkable from the fact that it is the only fruit in which such a structure has been found. *Ammophila arenaria* (fig. 42, Pl. V) presents a peculiar appearance. Its cotyledonary sheath extends down to the apex of the plumule. The scutellum also branches into three in the upper part.

Tribe AVENEÆ.

The *Aveneæ* resemble the *Hordeæ* in the structure of fruits. The embryo is usually small compared with the amount of endosperm. Lateral roots occur in *Avena*. The scutellum-bundle is inserted at the base of the plumule and continues down into the axis in the form of a loop.

Avena sativa (figs. 44, 45, 46 A–B, 47 A–G, 48, Pls. V and VI).—Fig. 47 A–G, Pl. V, represents a series of transverse sections through the embryo from the plumule to the radicles. At A one sees the peculiar shape of the scutellum, with its vascular bundle, while within is the plumule-sheath, with its bundles, inclosing the first true leaf. B represents a section taken somewhat lower down in the plumule and shows the position of the second leaf directly opposed to the first. The scutellum-bundle branches at the base of the plumule, as may be seen at C, to form the bundles of the plumule-sheath. Part of the plumule-sheath is still present, while within is the axis with the first leaf and its bundles just beginning to differentiate. Figs. D, E, and F show the axis, and the epiblast which becomes larger toward the base. At E only one radicle is present while at F there are three. G shows the position of the four radicles. The main radicle is in the center with one on each side to the right and left, and a fourth smaller one in front.

A longitudinal section of this small radicle may be seen in fig. 48, Pl. VI. The scutellum-bundle forms a loop in the axis as in fig. 48, a strand branching off from it forms the central bundle of the first true leaf. Fig. 45, Pl. V, represents a section facing the embryo. The main radicle with its two lateral radicles to the right and left are all surrounded by a coleorhiza. Figs. 44 and 46 A and B, Pl. V, represent longitudinal and transverse sections through the whole fruit showing the relative size of endosperm to embryo.

Holcus lanatus (fig. 51, Pl. VI.), *Arrhenatherum elatius* (fig. 49), and *Danthonia spicata* (fig. 50) all have a small epiblast and a single terminal radicle with the scutellum-bundle inserted directly under the plumule.

Tribe CHLORIDEÆ.

The *Chlorideæ*, according to the characters of their embryos, are more closely allied to the *Andropogoneæ* than to the *Aveneæ* and *Festuceæ*, with which they are placed in Hackel's classification. The fruit varies considerably both in regard to its form and the structure of the embryo. There is a spherical nut-like fruit, as in *Eleusine* (fig. 52 A–D, Pl. VI), with a well-marked epiblast, and a long linear fruit with an embryo more than half the size of the fruit itself and without an epiblast, as in *Spartina gracilis* (fig. 53). The scutellum is inserted on the axis at some distance from the plumule.

Eleusine coracana (fig. 52 A–D, Pl. VI).—This peculiar nut-like fruit has an embryo with a very large epiblast. The radicle is in a horizontal direction, while a deep groove is present between the scutellum and coleorhiza. The insertion of the scutellum-bundle is close to the base of the plumule, while the axis between the plumule and radicle is very short. Fig. 52 A represents a longitudinal section through the embryo, while at B we see the plumule with the large epiblast protecting it.

Spartina gracilis figs. 55, 54 A–C, Pl. VI).—In contrast to *Eleusine* it has a long linear fruit with an embryo reaching almost its whole length. The general appearance of the embryo reminds one of *Zizania aquatica*, as the insertion of the scutellum is a considerable distance from the plumule-sheath. One single vascular strand courses the lengthened node until it sends off a branch to the scutellum, and then continues down into the very small radicle. Fig. 54 A, B, C show sections through the radicle, lengthened node, and plumule, respectively. It is a noteworthy fact that this is the only genus of the *Chlorideæ* examined which does not have an epiblast.

Astrebla pectinata (fig. 55, Pl. VI).—The embryo of *Astrebla* is very large, with a very small epiblast. A deep groove is present between the scutellum and the coleorhiza. The scutellum-bundle is inserted on the axis at some distance from the plumule. The axis terminates in a single radicle, which preserves its root structure until just before it reaches the insertion of the scutellum, where vascular bundles appear.

Beckmannia erucæformis (fig. 60, Pl. VI), *Bulbilis dactyloides* (figs. 58 and 59, Pl. VI), and *Leptochloa imbricata* (fig. 56, Pl. VI) have about the same characteristics.

Tribe FESTUCEÆ.

The embryo of the *Festuceæ* is usually small. There is, according to Bruns, great variation in the presence and absence of an epiblast in this tribe.

Uniola latifolia (fig. 61, Pl. VII).—A broad epiblast reaches about half the length of the plumule. The scutellum-bundle is inserted on the axis at some distance from the plumule, while the single radicle is turned obliquely outwards.

Desmazeria sicula (fig. 63, Pl. VII), *Cynosurus cristatus* (fig. 64), and *Panicularia aquatica* (fig. 62, Pl. VII) all have the epiblast well marked. The scutellum-bundle differs from that of *Uniola* in being inserted directly at the base of the plumule. The axis terminates in a single radicle.

Tribe HORDEÆ.

The tribe *Hordeæ* may be characterized as having large fruits. The embryo usually has several radicles and a lateral bud in the axil of the plumule-sheath. A transition seems to take place between those without an epiblast, as in Hordeum (fig. 65, Pl. VII), and those with a distinctly formed epiblast as in *Triticum* (fig. 69, Pl. VII).

Hordeum vulgare (fig. 65, 66 A–H, Pl. VII). The fruit of *Hordeum vulgare* has many peculiarities not found in other grasses. There are two, and in some parts three, layers of gluten cells, while in nearly all grass fruits there is only one. This embryo often has, besides its main radicle, eight secondary ones, three on each side of the scutellum and two in front. In the axil of the plumule-sheath next the scutellum there is a large lateral bud (see p. 20). By examining figs. A–F it will be seen that the scutellum-bundle is composed of two strands which unite just before their insertion on the axis. The scutellum is inserted on the axis at the base of the plumule, a secondary radicle also emerging from it at this point, thus making the axis very short. At fig. 65 the bundles may be seen which belong to the first and second leaves and the vegetation point. Those of the plumule-sheath not being in the same plane are not represented. A transverse section through the upper part of the plumule (fig. 66) shows the opening in the sheath opposite to the scutellum and the two bundles situated laterally. Within is the upper part of the first true leaf. The scutellum shows a peculiar groove on its convex side next to the endosperm (fig. 66, A, B).

B shows a similar condition a little lower down through the plumule. At C and D the position of the first leaf opposite to the plumule-sheath, the second opposite the first, and the third opposite the second, according to the true distichous arrangement of all grass leaves may be noted.

E shows a section taken at the base of the plumule with the bundles in the axis which belong to the leaves of the plumule, also the two bundles of the disappearing plumule-sheath. At F the scutellum bundles are inserted on the axis. On the opposite side are two secondary radicles in the center of the bundles of the axis, while to the right and left appear the origin of the bundles of the plumule-sheath. At C the scutellum-bundles are no longer present, while three secondary radicles emerge from the axis. Four of the secondary radicles may be seen at H with the axis continuing down to form the main radicle. These radicles are all provided with a root-cap and surrounded by the coleorhiza. Although no epiblast is found here yet there is a slight prominence which might indicate its abortion.

Secale montanum (figs. 67, 68 A and B, Pl. VII).—The structure of the fruit of *Secale* resembles that of *Hordeum vulgare*. There is however only one secondary radicle. Not even a trace of an epiblast can be seen. The coleorhiza surrounds both radicles, forming a deep groove between them. At the base of the plumule-sheath next to the scutellum there is a lateral bud. The scutellum-bundle consists of a single strand, which is inserted on the axis almost directly at the base of the plumule. At this point branches are sent off into the plumule-sheath. The bundles in the axis belong to the leaves of the plumule while the axis continues down into the main radicle, a branch being sent off to the secondary radicle. Fig. 68 B represents a transverse section through the upper part of the plumule and A through the main and secondary radicles.

Elymus virginicus (figs. 72 and 73, Pl. VIII).—The fruit of *Elymus* has a very small embryo at the base of a long fruit. Although the epiblast is not present yet there is a slight elevation which might be regarded as a remnant of it. The scutellum-bundle consists of a single strand which curves around to the base of the plumule where it divides into three branches, two of them going into the plumule-sheath and the other continuing down into the axis and single radicle. A lateral bud is present in the axil of the plumule-sheath. Fig. 73 represents a transverse section through the upper part of the plumule.

Lolium rigidum (figs. 70, 71 A–C, Pl. VIII).—The embryo of *Lolium* resembles *Secale montanum* with only one large radicle. A lateral bud is present in the axil of the plumule-sheath.

Triticum æstivum (fig. 69, Pl. VII).—The fruit of *Triticum æstivum* has been so frequently described by previous writers that it is not necessary to treat it at length here. An excellent treatise by Bessey is to be found in Bull. 32 of the Nebraska Agr. Exp. Station, 1894. Its embryo has a small epiblast, a main radicle, and two secondary ones situated in front to the right and left. There is a prominent lateral bud in the axil of the plumule-sheath. In all other respects it resembles the tribe *Hordeæ*.

Tribe BAMBUSEÆ.

A small plant of *Arundinaria falcata* bloomed in the Cornell nursery during the summer of 1898. About a dozen fruits were secured and sections of the embryo made.

The fruit is oval and is covered by a pericarp, which easily separates from the endosperm and embryo. The embryo is small, with its scutellum almost completely surrounding the plumule (fig. 74, Pl. VIII). The vascular bundle traversing it is branched in all directions, as shown in any of the transverse sections (fig. 76 A–J, Pl. VIII).

The plumule-sheath differs from all other fruits of the *Gramineæ* investigated in having five vascular bundles instead of two. At its apex there is a well-marked slit or opening and only two vascular bunches (fig. 76 C). Figs. 76 D, E, F show the position of the five vascular bundles inclined toward the exterior side of the embryo.

The leaves have seven vascular bundles and are arranged as in all grass embryos (fig. 76 E). The epiblast is large and broad, but does not extend far up on the plumule. Toward the base it is rectangular in cross section (fig. 76 G, H). The axis terminates in one large radicle (fig. 76 K).

RELATIONSHIP AND SYSTEMATIC CONNECTION OF THE TRIBES.

Botanists disagree very generally as to which are the most primitive tribes of the grasses. The three great authorities on the subject are Hackel,[1] Bentham,[2] and Warming.[3] Their classifications are as follows:

BENTHAM'S CLASSIFICATION.

A. Panicaceæ.		*B. Poaceæ.*	
Tribe I.	Paniceæ.	Tribe VII.	Phalarideæ.
II.	Maydeæ.	VIII.	Agrostideæ.
III.	Oryzeæ.	IX.	Isachneæ.
IV.	Tristegineæ.	X.	Aveneæ.
V.	Zoysieæ.	XI.	Chlorideæ.
VI.	Andropogoneæ.	XII.	Festuceæ.
		XIII.	Hordeæ.
		XIV.	Bambuseæ

HACKEL'S CLASSIFICATION.

A. Panicaceæ.		*B. Poaceæ.*	
Tribe I.	Maydeæ.	Tribe VII.	Phalarideæ.
II.	Andropogoneæ.	VIII.	Agrostideæ.
III.	Zoysieæ.	IX.	Aveneæ.
IV.	Tristegineæ.	X.	Chlorideæ.
V.	Paniceæ.	XI.	Festuceæ.
VI.	Oryzeæ.	XII.	Hordeæ.
		XIII.	Bambuseæ.

[1] Hackel, E. Echte Græser. Engler and Prantl, Pflanzenfamilien, **2**[2]: 2. Eng. trans. by Scribner and Southworth, 1890.

[2] Bentham, Geo. "Notes on Gramineæ," Jour. of the Linn. Soc., **19**: 14–134, 1881–82.

[3] Warming, E., and Potter, C., Systematic Botany.

WARMING'S CLASSIFICATION.

Tribe I. Bambuseæ.	Tribe VII. Agrostideæ.
II. Oryzeæ.	VIII. Phalarideæ.
III. Maydeæ.	IX. Chlorideæ.
IV. Andropogoneæ.	X. Paniceæ.
V. Festuceæ.	XI. Hordeæ.
VI. Aveneæ.	

It will be noticed that Hackel's arrangement is in the main similar to that of Bentham, while Warming's varies, omitting the tribes *Zoysieæ* and *Tristegineæ*. Bentham, on the one hand, regards the tribes *Paniceæ*, *Maydeæ*, and *Oryzeæ*, while on the other, Hackel places the *Maydeæ*, *Andropogoneæ*, and *Zoysieæ* as the most primitive of the grasses. Warming, however, presents an entirely different view, and regards the *Bambuseæ* and *Oryzeæ* as the most primitive.

This great difference of opinion is probably due to the fact that the grasses have been largely studied from the basis of only a single character. Hackel[1] claims to have discovered the magic spell by which all difficulties must come to an end in regard to the arrangement of the genera of the *Andropogoneæ*, but it is to be doubted whether the same can be said of his arrangement of the tribes. The *Andropogoneæ* together with the *Maydeæ*, *Paniceæ*, *Tristegineæ*, and *Zoysieæ* without doubt represent a very natural group of the *Gramineæ*, but it is a question whether they are the most primitive. If one studies the *Andropogoneæ* from the standpoint of their resemblance to other Monocotyledons one is unable to find the slightest trace of such resemblances in any of the genera, while among the *Bambuseæ* and *Oryzeæ* there are many similarities.

The *Bambuseæ* are characterized as large, often tree-like, grasses, with woody, rarely herbaceous culms. The leaves are broad, sometimes compound and usually petioled. There are from three to six, or many, stamens while the prevailing number in the other *Gramineæ* is two or three. Usually three remarkably large lodicules[2] are present on the rhachilla. There is great variation in the structure and in the form of the fruit. Both Munro[3] and Hackel[4] use fruit characters to divide the different genera into sections. They may be classified as the berry-bearing and the true bamboos, the latter with linear or oblong-linear fruits, like those of *Avena* and *Triticum*, with a distinct furrow down one side and the scutellum visible below.

In the berry-bearing bamboos the caryopsis appears to be contained in an envelope somewhat analogous to the sac or perigynium which incloses the seed of *Carex*. In *Melocanna bambusoides* this covering

[1] Hackel, E., Andropogoneæ. De Candolle's Monographie Phaner.

[2] Rowlee, W. W. The Morphological Significance of the Lodicules of Grasses. Bot. Gaz. **25**: 199–203. 1898.

[3] Munro, Memoir on Bambuseæ. Trans. of the Linn. Soc. XXVI:

[4] Hackel, E., Echte Græser. Engler and Prantl, Pflanzenfamilien, II[2]: p. 92. Eng. trans. by Scribner and Southworth.

becomes very fleshy and the fruit attains the size of a large pear. *Schizostachyum acutiflorum* has very curious bundles of hairs on the scutellum, and the pericarp of the oblong fruit is quite loose and rugose. Some of the genera of the section *Triglosseæ* approach very closely in the structure of the spikelet the tribe *Paniceæ*.

The *Oryzeæ* may be compared with the *Bambuseæ*. In regard to their leaves there is a great variety of forms, from broad, ovate, petiolate leaves in *Pharus*, to long, linear ones in *Zizania*, and short, narrow leaves rounded at the apex in *Hydrochloa*. There is also great variation in the inflorescence. In some of the genera a number of bracts are arranged spirally around the main axis, while in others the inflorescence is inclosed in a spathiform envelope. The normal number of stamens is six, although they vary from one to eight. The pistil usually branches into two plumose stigmas, with occasionally a three-branched style, as in *Pharus*. The lodicules vary from 2 to 3. There are long, linear fruits, as in *Pharus*, and oblong-linear fruits, as in *Oryza*. The *Oryzeæ* therefore resemble the *Bambuseæ* in the following respects: (1) They show great variation in the structure of their fruit and spikelet. (2) Both have remarkably large epiblasts. (3) Some genera have the same number of lodicules. (4) *Pharus* has a style with three stigmas. (5) Many of the genera have broad petiolate leaves and transitions between these to linear ones. (6) They have to a great extent the same geographical distribution, the larger number of the genera being indigenous to tropical America. It would appear therefore that the *Oryzeæ* are closely related to the *Bambuseæ*, and that together they represent the most primitive of the grasses, thus bringing them nearer to the other Monocotyledons (e. g., *Palmaceæ*). So far as it has been observed there appears to be no similarity between the *Bambuseæ* and *Hordeæ*, although they are looked upon by both Bentham and Hackel as being closely allied.

The *Zoysieæ*, *Tristegineæ*, *Andropogoneæ*, *Maydeæ*, and *Paniceæ*, both according to the characters of the fruit and those of the inflorescence, according to Hackel's classification, form another natural group, joined to the *Oryzeæ* through the *Zoysieæ* and *Tristegineæ*. The *Chlorideæ*, although regarded by both Hackel and Warming as being removed some distance from the *Andropogoneæ*, are like them in their fruit characters.

The remaining tribes, *Phalarideæ*, *Agrostideæ*, *Aveneæ*, *Festuceæ*, and *Hordeæ*, from their fruit characters, form another group in the order named, which corresponds with the classification given by Hackel.

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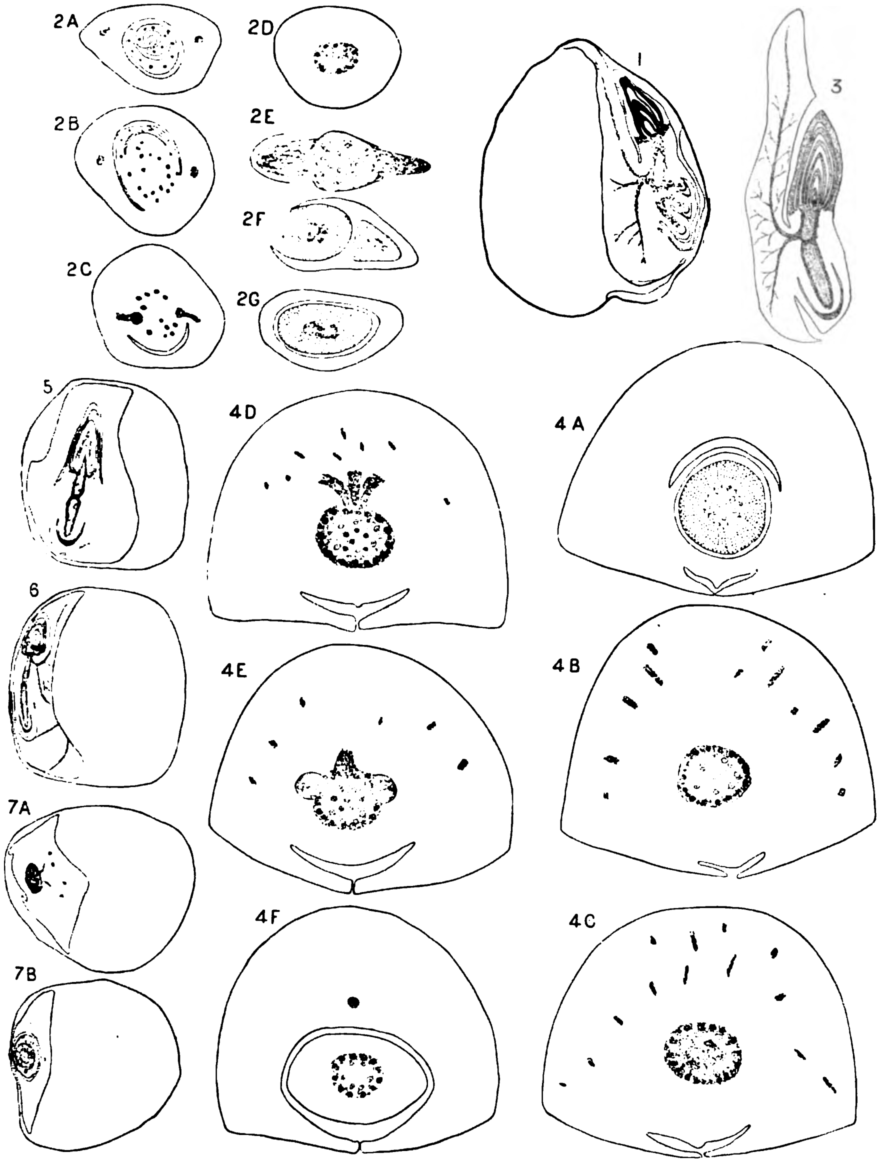

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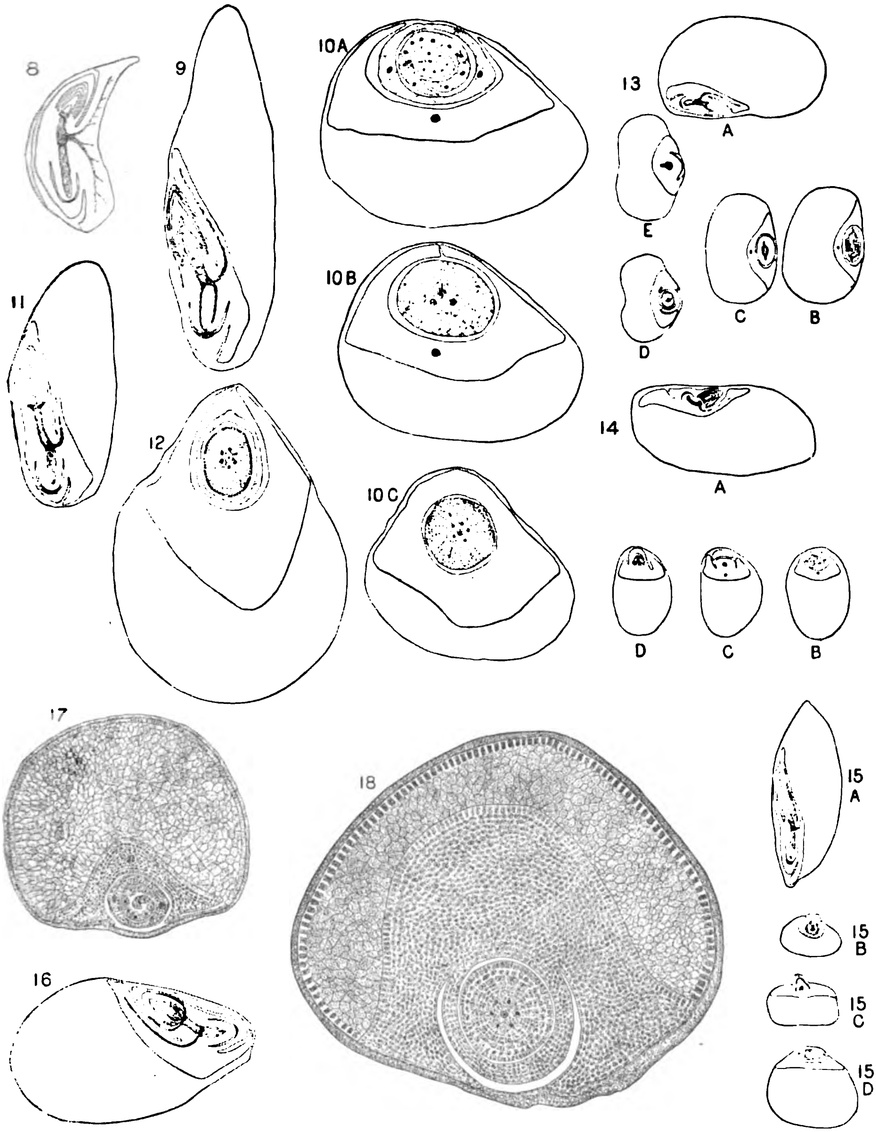

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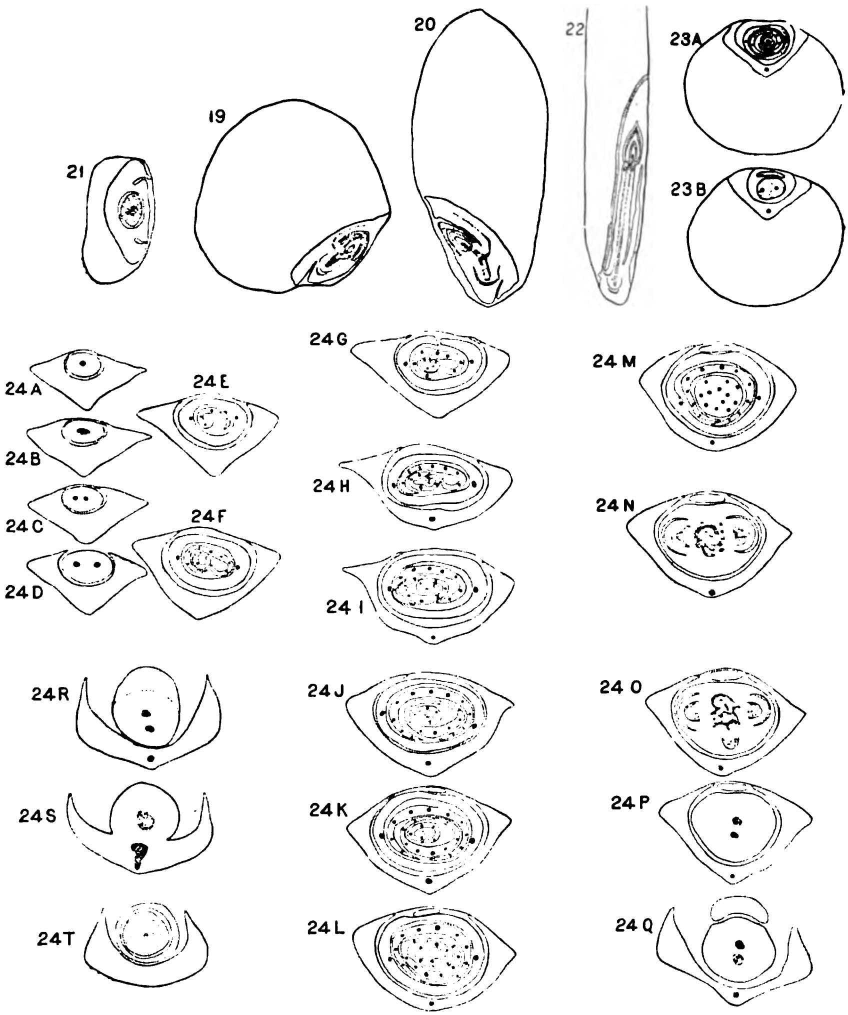

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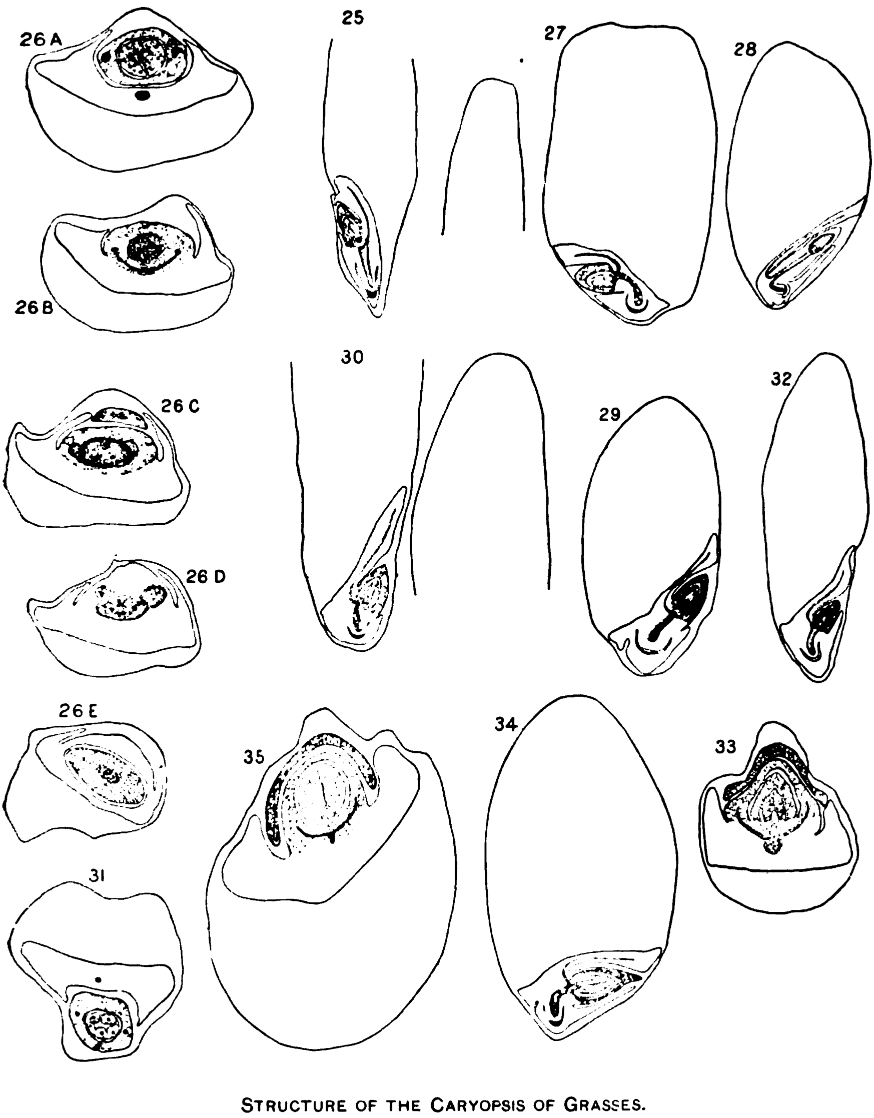

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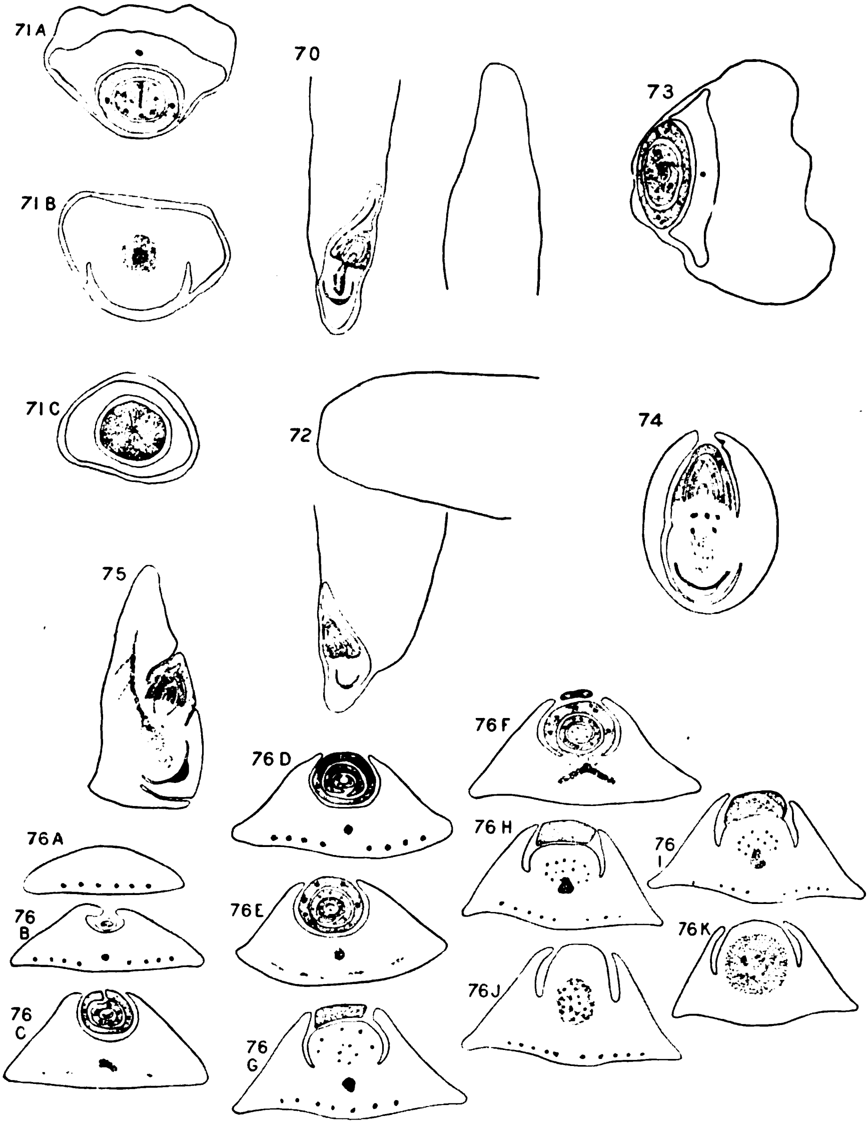

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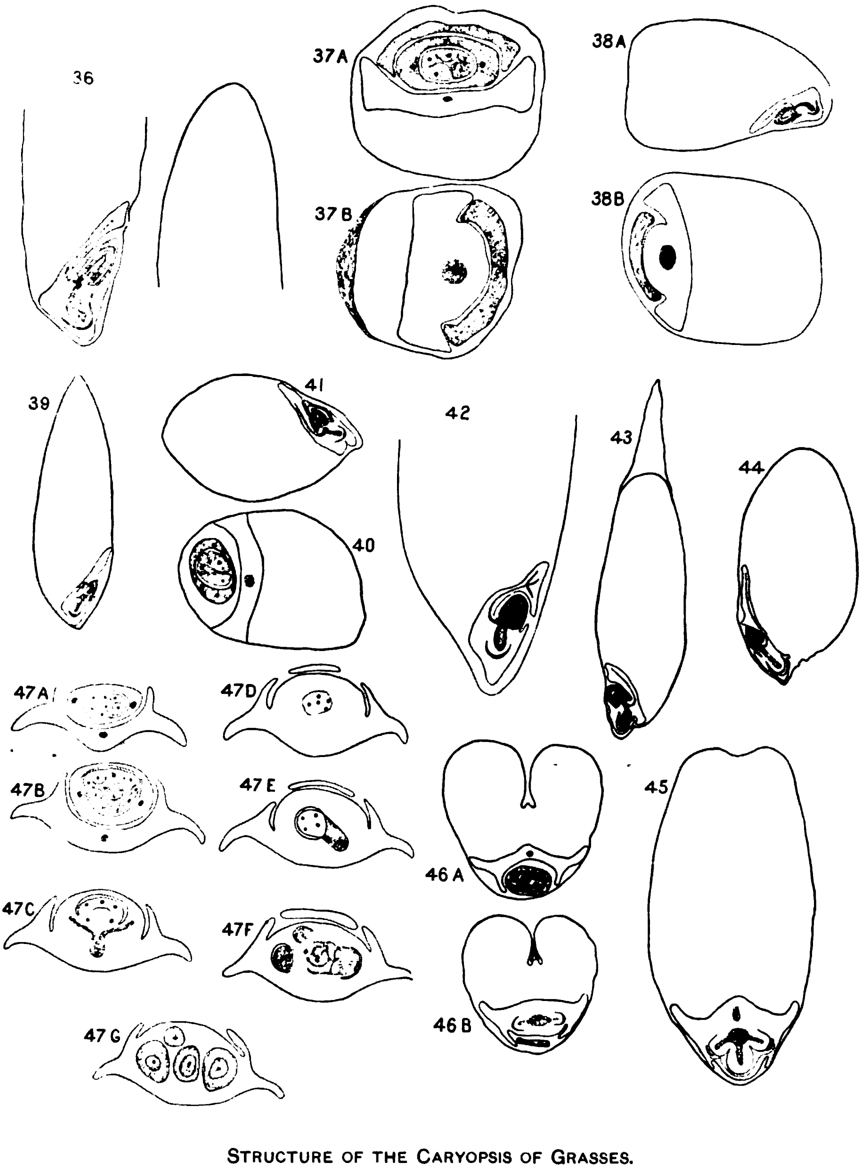

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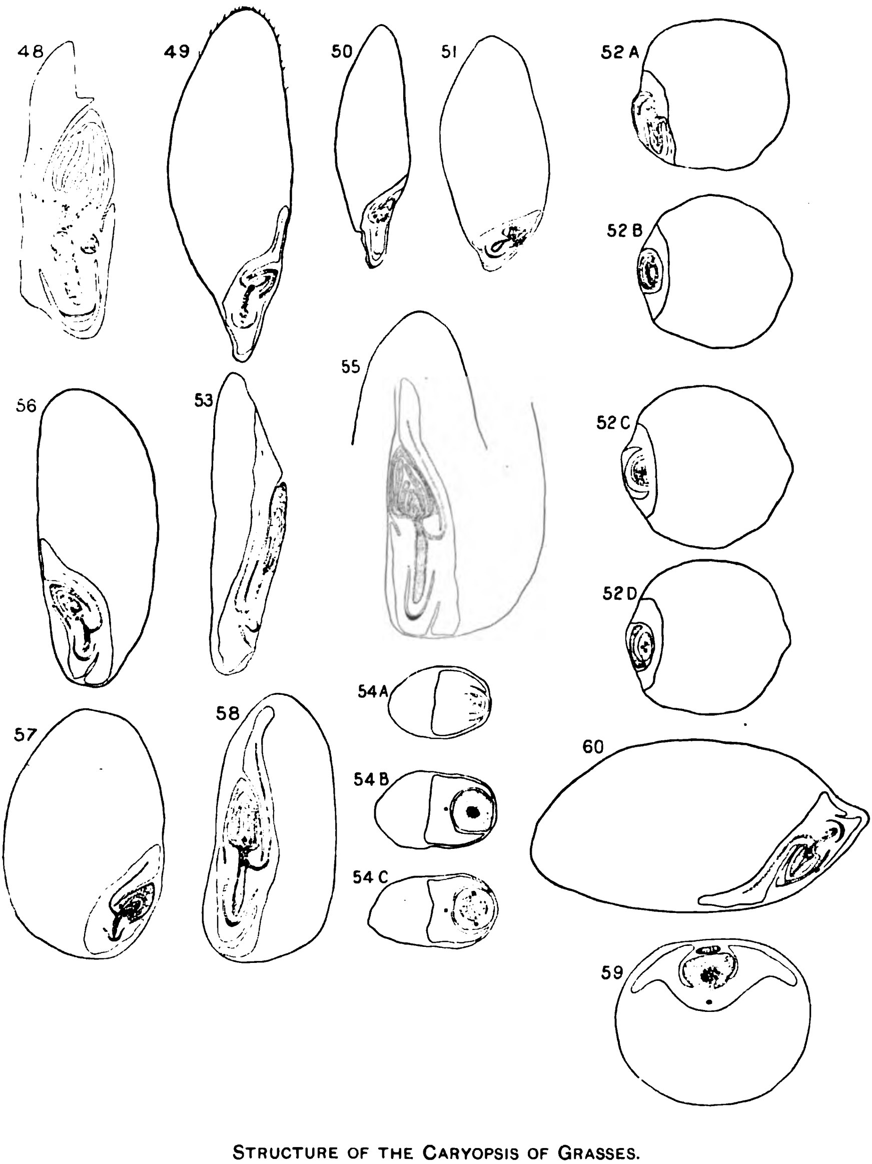

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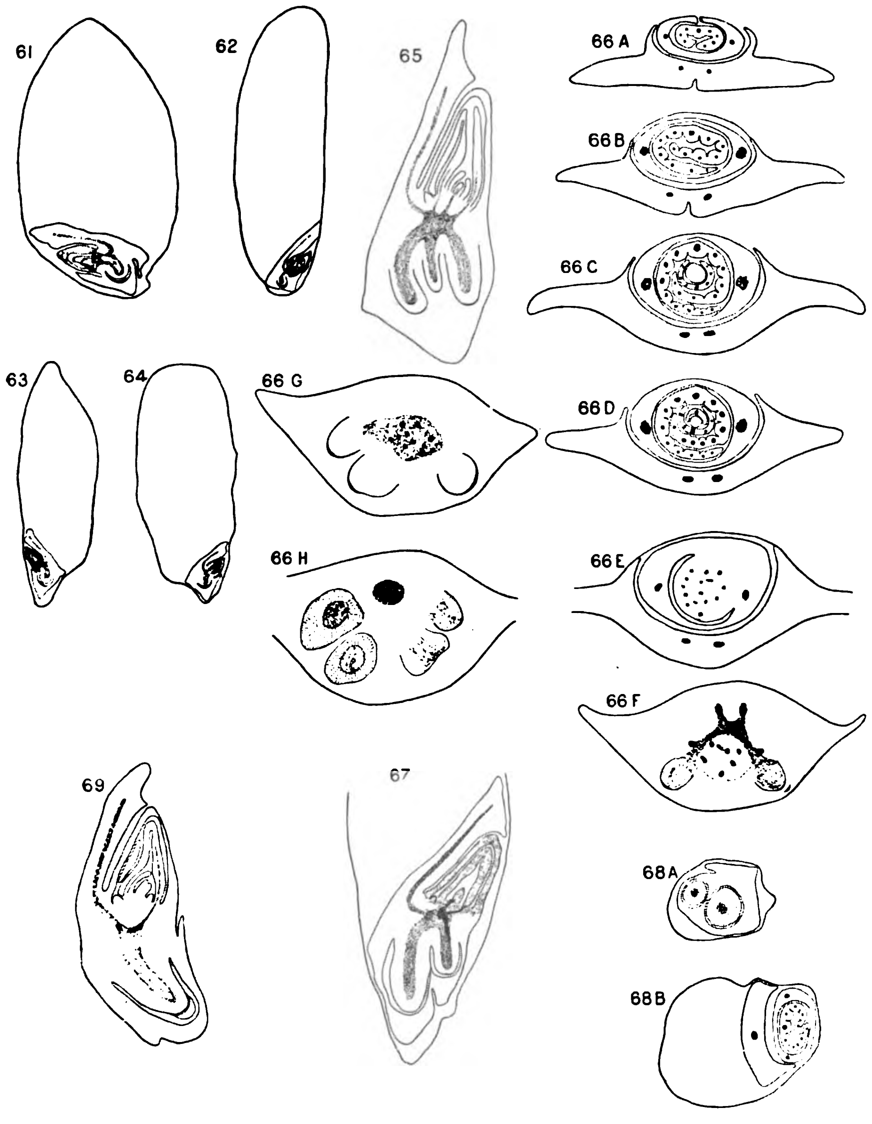

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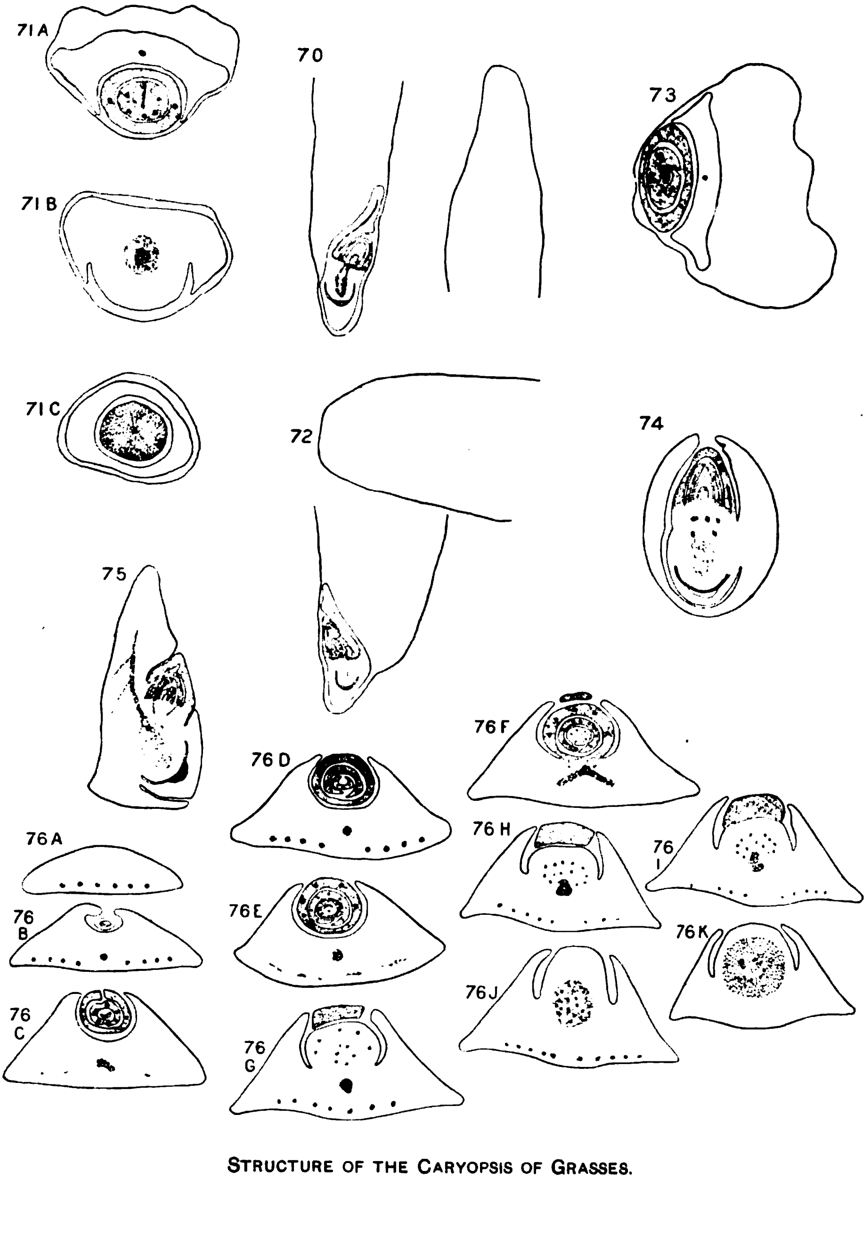

STRUCTURE OF THE CARYOPSIS OF GRASSES.

BULLETIN No. 21. Agros. 61.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

STUDIES

ON

AMERICAN GRASSES.

THE NORTH AMERICAN SPECIES OF CHÆTOCHLOA.

BY

F. LAMSON-SCRIBNER and ELMER D. MERRILL.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF AGROSTOLOGY,
Washington, D. C., January 15, 1900.

SIR: I have the honor to transmit herewith and recommend for publication as Bulletin No. 21 of this Division, and under the general title of "Studies on American Grasses," a revision of the North American species of *Chætochloa.*

In our manuals of the plants of the northern United States four species of *Chætochloa* are described, all introduced, three being common weeds, the fourth an occasional escape from cultivation. In Chapman's Southern Flora two additional and presumably native species are enumerated. In the paper here presented 28 North American species are described, 23 of which are natives of this continent. Six of the species enumerated are published here for the first time.

Acknowledgments are due Dr. B. L. Robinson, curator of the Gray Herbarium, for the loan of specimens and assistance in looking up authorities, etc., and to J. H. Burchell, of the Kew Herbarium, for assistance in the determinations by making comparisons with type material.

Respectfully,

F. LAMSON-SCRIBNER,
Agrostologist.

HON. JAMES WILSON,
Secretary of Agriculture.

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THE NORTH AMERICAN SPECIES OF CHÆTOCHLOA.

INTRODUCTION.

The North American species of *Chætochloa* have long been unsatisfactorily identified, and the present revision is offered in the hope of clearing up much of the existing confusion in this genus. It was at first proposed to consider only those species native of or introduced into the United States, but as the Mexican and West Indian species were found to be in an even more unsatisfactory condition than those of the United States, it seemed advisable to include such of these species as were represented in the material at hand.

In North America there are 28 species of *Chætochloa*, 6 of which are here published for the first time. Of these 28 species, 23 are native of North America, the remaining 5 having been introduced from Europe, of which 3 are cosmopolitan weeds found in the temperate regions of both hemispheres.

From an economic standpoint the genus takes high rank through the extensive cultivation of *C. italica*, various forms of which, under the names of millet, Hungarian grass, etc., are widely cultivated in this country as soiling or forage crops, and are among the oldest cultivated crops of the world, record having been found of its cultivation in China as early as 2700 B. C. In Europe its cultivation dates from prehistoric times, as the grain is found in abundance in the débris of the Lake Dwellings of the Stone Age in Switzerland.

The species are for the most part readily distinguished, except in the group represented by *C. imberbis*, which is extremely variable and is found in the warmer regions in both hemispheres. In general the details of the spikelets in this group are very similar, the variation being chiefly in the length and color of the panicles and setæ and in the vegetative characters. *C. gracilis* and *C. purpurascens* are here recognized as valid species, as they have certain constant characters by which they can be readily distinguished from related species. *C. macrostachya*, originally described from Mexican material and since credited to Asia and Australia, is confined to America, the Asiatic forms referred to this species are now referred to CHÆTOCHLOA FORBESIANA (Nees) n. comb. (*Panicum forbesianum* Nees) and the Australian form, which is very distinct from *C. macrostachya*, is here proposed as a new species. *C. composita*, a common southwestern

grass, has long been referred by botanists to *C. caudata* and *C. setosa*, from both of which it is very distinct.

"The name *Setaria*, which has been taken up by many botanists for a number of well-known weedy grasses with dense, spike-like, bristly panicles, was first applied by Beauvois (Flora Oware et Benin.) to a species of *Pennisetum*. At an earlier date the name was employed by Acharius to designate a genus of lichens. According to all rules of botanical nomenclature, this last fact renders the name untenable for designating a genus of flowering plants; and were this not the case, its first application to a species of *Pennisetum* placed it at once among the synonyms, which, according to recent rulings, would debar its further use. Some botanists have referred the grasses in question to the genus *Panicum*, from the species of which they differ only in the presence of setæ issuing from the pedicels of the spikelets below their articulation. It is this character, combined with their inflorescence, which led them to be separated from *Panicum*, in which genus the earlier described species were first placed. The taking up of the name *Chamæraphis*, a genus established by R. Brown upon certain Australian and south Asiatic grasses having spikelets like those of *Panicum*, but with the partial rachis of the inflorescence produced into long awn-like points beyond the insertion of the upper or only spikelet, appears to have been ill advised, and the more recent adoption of *Ixophorus* for *Setaria* is equally so. The latter genus, *Ixophorus*,[1] possesses well-marked characters of generic value, and the same is true of *Chamæraphis*. Neither of these names can be taken up for *Setaria*, unless they are used in a very broad sense to include all the species of *Panicum* thrown by Steudel into the section *Setaria;* that is, those species, as Schlechtendal states it, having "*spiculæ in axibus inflorescentiæ variæ evolutis pedicellatæ sessilesve, axium sterilium, setas æmulantium majore minoreve copia cum spiculis nascente.*" This would bring together a heterogeneous assemblage of species, the natural result of the adoption of characters too artificial, which, with our present ideas of genera, would be much more easily and more systematically treated if divided into genera upon more natural and genetic characters. While our Setarias, so called, might, under a broad conception of the genus *Panicum*, be referred to it, they seem to form a well-marked group, as indicated by the characters noted above, which it seems best to maintain as a genus, under the new name *Chætochloa*."[2]

CHÆTOCHLOA Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 38 (1897). *Setaria* Beauv. Agrost. 113 (1812), in part, not Fl. Oware et Benin. **2**: 80 (1807), nor Acharius (1798). *Chamæraphis* Kuntze in part, not R. Br. *Ixophorus* Nash (1895), not Schlecht. (1861–62).

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[1] Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 1. (1897.)
[2] Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 38. (1897.)

Spikelets hermaphrodite, usually 1-flowered. Glumes 4, the outer 3 membranous, the third often subtending a hyaline palea and rarely a staminate flower, the fourth or flowering glume chartaceous, smooth or transversely rugose, inclosing a palea of similar texture. Stamens 3. Styles distinct, elongated; setæ persistent, single or in clusters below the articulation of the rachilla; stigmas plumose. Grain free, inclosed within the glumes and palea.

Annual or perennial grasses with erect culms, flat leaves, and dense, cylindrical, or somewhat open bristly panicles.

Species about 40 in the tropical and more temperate regions of both hemispheres.

ANALYTICAL KEY TO THE SPECIES.

1. Setæ 5 to 16 at the base of each spikelet, involucrate 2
1. Setæ 1 to 3 at the base of each spikelet, not involucrate 5
2. Annual; setæ short, tawny-yellow .... 1 **C. glauca.**
2. Perennial, from short creeping rootstocks 3
3. Setæ short, once or twice as long as the spikelets; panicles slender 4
3. Setæ generally elongated, spreading; panicles thick .... 2 **C. imberbis.**
   (*a*) Setae very long, yellow or purple .... var. **penicillata.**
   (*b*) Plants not cæspitose; culms naked and wiry at the base; spikelets purplish .... var. **perennis.**
   (*c*) Plants robust, glaucous; culms erect; leaves long, rigid, erect; panicles pale green, elongated .... var. **streptobotrys.**
   (*d*) Plants robust; culms geniculate; panicles 6 to 12 cm. long, yellowish .... var. **geniculata.**
4. Leaves narrow, linear, elongated; panicle very slender, pale .... 4 **C. gracilis.**
4. Leaves linear-lanceolate, short; panicle thicker, usually purplish .... 3 **C. purpurascens.**
5. Second glume equaling the flowering glume in length 6
5. Second glume shorter than the flowering glume 15
6. Setæ antrorsely scabrous 7
6. Setæ retrorsely scabrous, wholly or in part 13
7. Flowering glume strongly transversely undulate-rugose .... 12 **C. longipila.**
7. Flowering glume smooth, or at least only punctate or striate, not rugose 8
8. Panicle dense, cylindrical; branches short, approximate, densely flowered ... 9
8. Panicle lax; branches remote, generally elongated, few-flowered 12
9. Flowering glume very smooth, glossy; plants robust, 18 to 36 dm. high .... 11 **C. magna.**
9. Flowering glume more or less roughened, not glossy; plants less than 18 dm. high 10
10. Axis of the inflorescence scabrous; branches subverticillate .... 8 **C. ambigua.**
10. Axis of the inflorescence pilose; branches alternate 11
11. Panicles 2 to 8 cm. long, 1 cm. or less thick; spikelets 2 mm. long, much exceeded by the usually green setæ .... 9 **C. viridis.**
11. Panicles 5 to 20 cm. long, 1 to 3 cm. thick; spikelets about 2.3 mm. long, equaled or exceeded by the usually purple setæ; cultivated.... 10 **C. italica.**
    (*a*) Culms 3 to 9 dm. high; panicle 1 cm. in diameter; setæ long, purple, rarely green .... var. **germanica.**
12. Spikelets 3 mm. long .... 24 **C. villosissima.**
12. Spikelets 2 mm. long .... 25 **C. grisebachii.**
13. Setæ retrorsely scabrous above, antrorsely scabrous at the base; leaves pubescent .... 7 **C. scandens.**
13. Setæ retrorsely scabrous throughout; leaves scabrous 14
14. Panicles 1.5 to 3 cm. long, 1 cm. thick, purplish .... 5 **C. brevispica.**

14. Panicles 5 to 18 cm. long, tapering to the obtuse apex, green, rarely purplish .... 6 **C. verticillata.**
15. Spikelets 3 mm. long 16
15. Spikelets less than 3 mm. long 18
16. Leaves smooth or scabrous 17
16. Leaves pilose-pubescent .... 24 **C. villosissima.**
17. Leaves lanceolate, 10 to 20 mm. wide; panicle loose; branches elongated, few-flowered .... 23 **C. macrosperma.**
17. Leaves linear, glaucous, 2 to 5 mm. wide; panicle subspiciform; branches densely flowered .... 18 **C. composita.**
18. Inflorescence spike-like, dense; branches very short, approximate 19
18. Inflorescence lax, interrupted; branches more or less elongated 24
19. Flowering glume strongly transversely undulate-rugose 20
19. Flowering glume smooth or only finely transversely wrinkled 23
20. Leaves smooth or scabrous .... 13 **C. corrugata.**
    (*a*) Spikes 5 to 7 cm. long; setæ usually purplish, spreading.. var. **parviflora.**
20. Leaves pubescent or pilose 21
21. Leaves lanceolate, acute, 12 to 15 mm. wide; setæ long.......... 21 **C. latifolia.**
    (*a*) Leaves 10 mm. wide or less; setæ short.................. var. **breviseta.**
21. Leaves linear or linear-lanceolate, about 5 mm. wide 22
22. Culms pilose with scattered hairs; fertile palea nearly plane.... 15 **C. hispida.**
22. Culms smooth; fertile palea strongly convex .... 14 **C. gibbosa.**
23. Leaves pilose; plants 2 to 3 dm. high .... 16 **C. leucopila.**
23. Leaves smooth or scabrous, glaucous; plants robust, 4 to 9 dm. high. .... 18 **C. composita.**
24. Setæ antrorsely and more sparingly retrorsely scabrous.......... 17 **C. onurus.**
24. Setæ antrorsely scabrous only 25
25. Flowering glume very strongly transversely undulate-rugose.................. 26
25. Flowering glume smooth or only finely transversely wrinkled.............. 27
26. Leaves and rachis pilose .... 21 **C. latifolia.**
26. Leaves and rachis scabrous .... 22 **C. liebmanni.**
    (*a*) Branches of the panicle very short; leaves 1 dm. long or less, 8 to 10 mm. wide .... var. **pauciflora.**
27. Leaves linear 28
27. Leaves lanceolate or linear-lanceolate 29
28. Leaves glaucous; panicle pale, obtuse at the apex............ 18 **C. composita.**
28. Leaves pubescent; panicle long-attenuate at the apex .... 27 **C. caudata.**
29. Panicle subcylindrical; branches densely flowered 30
29. Panicle more lax; branches loosely few-flowered 31
30. Margins of the sheaths smooth; setæ short .... 20 **C. rigida.**
30. Margins of the sheaths ciliate-fringed; setæ long, spreading .... 19 **C. macrostachya.**
31. Flowering glume manifestly transversely wrinkled 32
31. Flowering glume smooth or only pitted or striate.......... 25 **C. grisebachii.**
    (*a*) Plants densely cæspitose, less than 1 dm. high .... var. **mexicana.**
    (*b*) Plants robust, 5 to 8 dm. high; branches of the panicle elongated, spreading, the lower ones 2 to 3.5 cm. long .... var. **ampla.**
32. Panicle long-attenuate at the apex; branches strict, erect; leaves pubescent .... 28 **C. setosa.**
32. Panicle obtuse at the apex; branches spreading; leaves smooth or pilose .... 26 **C. polystachya.**

A. *Setæ 5 to 16, involucrate.*

**Annual.*

1. **Chætochloa glauca**[1] (L.) Scribn. U. S. Dept. Agr., Div. Agros. Bul **4**: 39 (1897). *Panicum glaucum* L. Sp. Pl. 56 (1753). *Setaria glauca* Beauv. Agrost. 51 (1812). *Chamæraphis glauca* Kuntze Rev. Gen. Pl. **2**: 767 (1891). *Ixophorus glaucus* Nash Bul. Torr. Bot. Club **22**: 423 (1895). (Fig. 1.)

An erect or ascending somewhat cæspitose, glaucous annual 3 to 12 dm. high, with flat, lanceolate or linear-lanceolate leaves, and dense, bristly, cylindrical, spike-like, yellowish panicles 2 to 10 cm. long. Culms branching at the base, geniculate, compressed, glabrous; nodes brown, smooth; sheaths glabrous, loose, compressed, margins hyaline, smooth; ligule short, ciliate; leaf blades 0.5 to 1.5 dm. long, 4 to 8 mm. wide, long-acuminate, glaucous, nearly glabrous, or scabrous on the upper surface and margins, generally pilose, with scattered long white hairs at the base. Panicles dense, linear-ovate, obtuse, about 1 cm. in diameter; rachis angular, pubescent; setæ involucrate, 5 to 12 at each spikelet, straight, or subflexuous, unequal, antrorsely scabrous, yellow, 3 to 8 mm. long. Spikelets broadly ovate, 3 mm. long, 2 mm. broad, acute or obtuse; first glume one-third to one-half as long as the spikelet, acute, 3-nerved; second glume one-half to two-thirds as long as the spikelet, broadly ovate, acute, 5-nerved, the mid-nerve excurrent, the lateral ones anastomosing with it; third glume 5-nerved, equaling the flowering glume, subtending a broadly-lanceolate, hyaline palea nearly its own length; flowering glume broad-ovate, acute, 2.5 mm. long, striate, transversely undulate-rugose, the inclosed palea broad, convex at the base, concave above, transversely striate.

FIG. 1.—*Chætochloa glauca*: *a*, view of the spikelet showing the setæ; *b*, spikelet showing the first and third glumes.

In waste places and cultivated grounds widely distributed in North America. Naturalized from Europe. July–September.

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[1] CHÆTOCHLOA APICULATA sp. nov.

An erect, cæspitose, perennial (?), 2 to 4 dm. high, with rather rigid leaves, large spikelets, and long, erect setæ. Culms slender, slightly geniculate and generally much branched at the base, glabrous or slightly scabrous; nodes smooth; sheaths

SPECIMENS EXAMINED.—*Ottawa:* Macoun 1884. *Maine:* Rumford, Parlin 1889; Auburn, Merrill 1898. *New Hampshire:* Jaffrey, 284 Robinson 1897. *Massachusetts:* Great Barrington, Pollard 1894; South Hadley, Clark 1887. *Connecticut:* South Glastonbury, 25 Wilson 1892. *New York:* Oxford, Coville 1884; New York, Kenyon 1889. *New Jersey:* Weehawken, Van Sickle 1895. *Pennsylvania:* Conewago, Small; Philadelphia, Smith; Easton, Porter 1896. *Delaware:* 146 Commons 1897. *District of Columbia:* Vasey 1885. *Ohio:* Ricksecker 1894. *Michigan:* Keweenaw Co., 537 Farwell 1886. *Tennessee:* Knoxville, Scribner. *Iowa:* Fayette Co., Fink 1894; Ames, 180 Ball 1896. *Kansas:* Manhattan, Bassler, 1883; Riley Co., 575 Norton 1895. *Missouri:* 266 Eggert 1886. *Wisconsin:* Oshkosh, Random 1896. *South Dakota:* Bellefourche, 366 Griffiths 1897; Redfield, 221 Griffiths 1897; Frankfort, 54 Griffiths 1897. *North Carolina:* Magnetic City, Wetherby 1895. *Alabama:* McCarthy 1888. *Louisiana:* Ascension, 1409 Combs 1898; Rayville, 23*a* Ball 1898; Calhoun, 44 Ball 1898; Shreveport, 97 Ball 1898.

****Perennial.*

2. **Chætochloa imberbis** (Poir.) Scribn.; U. S. Dept. Agr., Div. Agros. Bul. **4:** 37 (1897). *Panicum imberbe* Poir. Encycl. Suppl. **4:** 272 (1817). *Panicum lævigatum* Muhl. in Elliott Sk. Bot. S. Car. & Ga. **1:** 112 (1817). *Chætochloa lævigata* Scribn. *Chætochloa perennis* (Curtiss) Bicknell Bul. Torr. Bot. Club **25:** 107 (1898).

An erect or ascending, more or less caespitose, glabrous perennial, 3 to 7 dm. high, from short, creeping rootstocks, with linear-lanceolate leaves and dense, exserted, cylindrical panicles. Culms slender, compressed, generally somewhat geniculate at the base, scabrous below the panicle, otherwise very smooth; nodes glabrous; sheaths glabrous, compressed, the lower much longer than the internodes, imbricate, distichous, smooth on the hyaline margins; ligule ciliate, with very short hairs; leaf-blades 1 to 3 dm. long, 3 to 7 mm. wide, scarcely narrowed at the base, long-tapering to the apex, slightly scabrous on the upper surface and margins, glabrous below, sometimes with a few long white hairs at the throat. Panicles dense, spike-like, 2 to 5 cm. long, nearly 1 cm. in diameter, exclusive of the setæ; rachis angular, pubescent; branches short, contiguous, 1 or rarely 2-flowered; setæ 8 to 12, involucrate, spreading, 5 to 10 mm. long, unequal, slender, pale, yellowish or sometimes purplish, finely antrorsely scabrous. Spikelets ovate, acute, 2 to 2.5 mm. long; first glume about one-third as long as the spikelet, ovate, acute or obtuse, 3-nerved; second glume one-half to two-thirds as long as the spikelet, ovate, acute, 5 to 7 nerved, the mid-nerve excurrent, the lateral ones anastomosing or abruptly vanishing in the hyaline margin; third glume equaling the flowering glume and slightly inclosing it by

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about equaling the nodes, striate, glabrous, margins hyaline, smooth; ligule very short, ciliate-fringed; leaf-blades plane or becoming involute in drying, 1 to 3 dm. long, 3 to 6 mm. wide, long, slender, acuminate, scabrous, usually bearded with few long white hairs at the throat and sparingly pilose. Panicles pale, dense, cylindrical, spiciform, 2 to 5 cm. long, 5 to 6 mm. in diameter; rachis pubescent; branches very short, generally 1-flowered; setæ 6 to 10, involucrate, spreading-erect, 1 to 1.5 cm. long, antrorsely scabrous, pale. Spikelets 3 to 3.5 mm. long, broadly ovate, acute, apiculate; first glume one-half as long as the spikelet, narrowly cordate, acuminate, 5-nerved; second glume about as long as the spikelet, 7-nerved, acute, apiculate; third glume equaling the spikelet, sulcate, 7-nerved, subtending a lanceolate, hyaline palea nearly its own length; flowering glume broadly ovate or rotund-ovate, acute, apiculate, strongly transversely undulate-rugose, the inclosed palea nearly smooth, plane.

Australia.

Type specimen collected by F. von Mueller, Victoria River, Queensland. **Distributed** under the name *Setaria glauca* Beauv., but at once distinguished by its narrower leaves, long setæ, larger spikelets, longer first and second glumes, and more strongly rugose flowering glume, all the glumes being prominently apiculate.

its infolded margins, acute, apiculate, 5-nerved, sulcate, subtending a broad, hyaline palea of its own length; flowering glume elliptical-ovate, acute, striate, finely transversely rugose for its whole length, the inclosed palea slightly convex at the base, plane or concave above.

In moist soil, New Jersey to Florida and Texas, north to Kansas and Missouri; Mexico, West Indies, South America. May–October.

Specimens examined.—*New Jersey:* Holmes 1890. *North Carolina:* Biltmore, 6026*a* Biltmore Herb. 1898; no locality, McCarthy 1889. *South Carolina:* Santee Canal, Ravenel. *Georgia:* Augusta, 200 Kearney 1895. *Florida:* Duval Co., 3614 Curtiss 1883; Jacksonville, 4745 Curtiss 1894, 5411Curtiss 1895, 19 Combs 1898; Bay Head, 659 Combs 1898; Cedar Key, 775 Combs 1898; Eustis, 566 Nash 1894. *Alabama:* Mobile, 42, 58 Kearney 1895. *Mississippi:* Chandeleur Island, Tracy 1897; Agricultural College, 34 Kearney 1896; Starkville, 22 Kearney 1896; *Louisiana:* New Orleans, 343 Kearney 1896; Oberlin, 218 Ball 1898; Pointe-à-la-Hache, 54 Langlois 1883. *Indian Territory:* Verdigris, 744 Bush 1894. *Texas:* Hampstead, 840 Hall 1872; Bexar Co., 207 Jermy; Pinto Creek, Kinney Co., 82 Hill 1895; Kerrville, 1889 Heller 1894; Home Canyon, 423 Carleton 1891; Houston, 15 Engelmann 1842; Ennis, Smith 1897; Dallas, Reverchon 1875; without locality, C. Wright 1849; Nealley 1884; Reverchon 1879, 1883. *New Mexico:* Drummond, 984 Fendler 1847. *West Indies:* St. Thomas, 185 Eggers 1880. *Cuba:* 3888 Wright 1865. *Puerto Rico:* 208 Sintenis 1884. *Mexico:* 536 Gregg 1848–49; Cuicatlan, 1652 Nelson 1894; Guadalajara, 246 Palmer 1886. *Lower California:* San Jose del Cabo, 15 Brandegee 1890.

Very readily distinguished from *C. glauca* (L.) Scribn., to which it has been referred as a variety and with which it is confused, by its perennial roots, longer, glabrous leaves, longer setæ and smaller spikelets.

This variable species has long passed under the name *Setaria lævigata*, but from careful consideration it would seem that *imberbis* is the proper name. Trinius (Icon. t. 196, Fig. A) says in his description of the plate that Fig. A is *Setaria gracilis* Kunth, which can hardly be a synonym of *Panicum imberbe* Poir.,[1] but below in referring to the plate he calls Fig. A *Setaria imberbis;* hence the confusion regarding this species. Poiret in his original description says that the specimens on which he based this species were from Carolina, Puerto Rico, and Brazil, and that they differed from *Panicum glaucum* of Europe not only in having the bristles of the involucre longer, but also by the leaves being destitute of hairs at the apex of the sheaths.

Chætochloa gracilis, the slender form of Trinius t. 196, does not grow naturally north of Texas, and, moreover, it can not be Poiret's *Panicum imberbe*, as is seen from the original description.

CHÆTOCHLOA IMBERBIS PENICILLATA (Nees) n. comb. *Panicum penicillatum* Nees. Agrost. Bras. 242 (1829). (Fig. 2.)

An erect or ascending perennial, sometimes rooting at the lower nodes, with panicles 3 to 12 cm. long, and long, widely spreading yellow, brown, or purplish setæ, otherwise as in the type.

In fields and pine woods Georgia to Texas, Mexico, and South America.

Specimens examined.—*Georgia:* Augusta, 227 Kearney 1895; Savannah, 186 Kearney 1895. *Florida:* Waldo, 702 Combs 1898; Lake City, 83, 179 Combs & Rolfs 1899; Monticello, 346 Combs 1898; Old Town, 877 Combs 1898; Quincy, 396 Combs 1898; Apalachicola, 116 Kearney 1895. *Louisiana:* Pointe-à-la-Hache, 55 Langlois 1880; Calhoun, 41 Ball 1898. *Mississippi:* Ocean Springs, 1105. Pollard 1896; Biloxi, 217 Kearney 1896. *Texas:* Ennis, J. G. Smith 1897, without locality; Hall 1872; Nealley 1887.

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[1] Cujus syn. vix erit *P. imberbe* Poir.

CHÆTOCHLOA IMBERBIS PERENNIS (Hall) n. comb. *Setaria perennis* Hall, Trans. Kans. Acad. Sci. **13**: 102 (1893). *Chætochloa versicolor* Bick. Bul. Torr. Bot. Club. **25**: 105, pl. 328 (1898).

A slender, scarcely tufted, loose form, 6 to 12 dm. high, with very slender wiry culms, which are naked below, long, narrow leaves, and rather slender, long-exserted panicles, 2.5 to 7 cm. long. Spikelets generally purplish. Setæ very slender, 6 to 10 mm. long, yellowish-green or purple.

FIG. 2.—*Chætochloa imberbis penicillata:* *a*, spikelet showing the setæ; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

In brackish marshes, along the coast from Connecticut to Florida and Mississippi, and in alkaline and saline bottoms, Kansas and Indian Territory. June–September.

SPECIMENS EXAMINED.—*Maryland:* Bay Ridge, Scribner 1897; Takoma Park, Williams 1899. *Florida:* Barstow, 1232 Combs 1898; Homosassa, 924, 969 Combs 1898; Jacksonville, 13 Combs 1898; Lake City, 79 Combs 1898; Madison, 237 Combs 1898; Cedar Key, 794 Combs 1898; Ellzey, 826 Combs 1898. *Louisiana:* Alexandria, 185 Ball 1898. *Mississippi:* Biloxi, Tracy 1898. *Indian Territory:* Bigelow 1853–54. *Kansas:* Comanche Co. 1544 Hitchcock 1896; Hutchinson, 2 Smyth 1890.

This form is not worthy of specific rank, as all gradations are found between it and the typical *C. imberbis*. The characters used by Bicknell in separating his species, such as the longer and fewer nerved glumes, absence of hairs at the base of the leaves, purplish flowering glume, etc., are not constant, but are found to be extremely variable.

CHÆTOCHLOA IMBERBIS GENICULATA (Lam.) n. comb. *Panicum geniculatum* Lam. Encycl. **4**: 727 (err. typ. 737) (1797). *Setaria geniculata* Beauv. Agrost. 51 (1812). *Chamæraphis glauca geniculata* Beal, Grasses of N. Am. **2**: 156 (1896).

A stout, glaucous form, 5 to 10 dm. high, with geniculate culms, broader leaves, and elongated panicles 6 to 12 cm. in length; leaf-blades 1 to 3 dm. in length, 5 to 8 mm. wide. Panicles erect, yellowish, 5 to 8 mm. in diameter. Spikelets as in the type.

West Indies, Mexico, South America.

Specimens examined.—*Mexico:* Durango, 378, 471, 539 Palmer 1896; Rio Hondo, 3156 Holway 1898; Jalisco, Guadalajara, 293 Palmer 1886; Oaxaca, 5723 Galeotti 1840; 342 Conzatti & Gonzalez 1897; 710 Nelson 1894; Coahuila, 431 Pringle 1885; Guanajuato, Dugès 1893; Orizaba, 631 Botteri, 2639 Bourgeau, 1865–66; 115 Seaton 1891; San Luis Potosi, 1041 Schaffner 1876; without locality, Ghiesbreght 1842. *Cuba:* 3472 Wright 1860–64. *St. Croix:* 243 Ricksecker 1896. *Puerto Rico:* 6861 Sintenis 1887.

Fournier[1] makes a variety *latifolia* of this species (*Setaria geniculata*), based on 2639 Bourgeau and 5723 Galeotti, both of which are represented in the Gray Herbarium. In these specimens none of the leaves exceed 8 mm. (4 lines) in width. In the original description the leaves are described as "*longues, larges du trois à quartre lignes, planes, glabres,*" etc. In other specimens cited by Fournier as representing the type 350 Liebmann and Ghiesbreght 1842, represented in the United States National Herbarium, the plants are depauperate, with narrow leaves, not exceeding 6 mm. wide, and shorter, narrower spikes. In Jaquin[2] the description and plate represent the type as having broad leaves and thick, elongated spikes; hence it would seem that Fournier had a wrong idea of the type, which is best represented by his variety *latifolia*.

Fig. 3.—*Chætochloa purpurascens:* a, spikelet showing the setæ; b, spikelet showing the first and third glumes; c, flowering glume, dorsal view.

CHÆTOCHLOA IMBERBIS STREPTOBOTRYS (Fourn.) n. comb. *Setaria streptobotrys* Fourn. Mex. Pl. Enum. Gram. 47 (1886).

A pale, glaucous form, 4 to 6 dm. high, with stout, erect culms, linear-lanceolate, glaucous, and nearly glabrous leaves and pale-green panicles, 6 to 10 cm. long, about 6 mm. in diameter; setæ pale-green, spreading. Closely related to var. *geniculata*.

Mexico.

Specimens examined.—*Mexico:* Oaxaca, 342 Conzatti & Gonzalez 1897; Coahuila, 431 Pringle 1885; Durango, 378, 381, 471 Palmer 1896.

3. **CHÆTOCHLOA PURPURASCENS** (H. B. K.) n. comb. *Setaria purpurascens* H. B. K. Nov. Gen. & Sp. Pl. **1**: 110 (1815). (Fig. 3.)

An erect or ascending, cæspitose perennial, 1 to 6 dm. high, from short, creeping rootstocks, with short, lanceolate or linear-lanceolate leaves, short setæ, and dense,

[1] Mex. Pl. Enum. Gram. 46.

[2] Eclogæ Gram. t. 27, *Pennisetum geniculatum.*

cylindrical, usually purplish, spiciform panicles, 1 to 5 cm. in length. Culms slender, branching, and geniculate at the base, glabrous; nodes smooth; sheaths loose, striate, glabrous, shorter than the internodes, margins smooth; ligule very short, ciliate; leaf-blades 5 to 10 cm. long, 4 to 6 mm. wide, scabrous on both sides and on the cartilaginous margins, sometimes nearly smooth beneath, not narrowed at the cordate base, acute or acuminate. Panicles about 5 mm. in diameter, somewhat exserted; rachis angular, pubescent; branches very short, 1 or 2 flowered, approximate; setæ 5 to 10, short, unequal, involucrate, 3 to 8 mm. long, flexuous, green or purplish, often barely exceeding the spikelets, antrorsely scabrous. Spikelets ovate, acute, 2 mm. long; first glume ovate, acute, 3-nerved, one-third as long as the spikelet; second glume ovate, acute or obtuse, about one-half as long as the spikelet, 5-nerved, mid-nerve excurrent, the lateral ones anastomosing or vanishing in the hyaline margins; third glume equaling the flowering glume, 5-nerved, sulcate, subtending a broadly ovate, hyaline palea of its own length; flowering glume ovate, acute, transversely undulate-striate for its whole length, the inclosed palea equaling it in length, striate, plane.

Texas to Mexico, West Indies, Central and South America.

Specimens examined.—*Texas:* San Diego, Smith 1897; Bexar Co., 207 Jermy; Dallas, Reverchon 1876. *Cuba:* 3472 Wright 1865. *Mexico:* Chiapas, 3023*a*, 3336 Nelson 1895; City of Mexico, 7 Holway 1896; 3126 Holway 1898; Orizaba, 114, 247 Seaton 1891; 33 Nelson 1894; Plunia, 2482 Nelson 1895; Puebla, Nelson 1893; Chinantha, 350 Liebmann 1841, cited by Fournier[1] under *Setaria geniculata;* valley of Mexico, 231 Bourgeau 1865–66; Colipa, 360 Liebmann 1841, cited by Fournier under *Setaria flava.*

Fig. 4.—*Chætochloa gracilis: a*, spikelet showing the setæ and second glume; *b*, spikelet showing the first and third glumes; *c*, flowering glume, dorsal view.

An extremely variable species, at once distinguished from the closely related *C. gracilis* by its shorter, lanceolate or linear-lanceolate leaves and thicker, usually purplish spikes. The form which Fournier referred to *Setaria flava* Kunth, differs from

[1] Mex. Pl. Enum. Gram. 45.

the typical material only in having the panicle pale instead of purple, or at least only the spikelets being tipped with purple.

4. **CHÆTOCHLOA GRACILIS** (H. B. K.) n. comb. *Setaria gracilis* H. B. K. Nov. Gen. & Sp. Pl. **1**: 109 (1815). *Setaria imberbis* R. & S. of authors. (Fig. 4.)

A slender, erect, glabrous, cæspitose perennial, 3 to 7 dm. high, from short, creeping rootstocks, with linear-setaceous leaves, very slender, spike-like panicles 2 to 6 cm. in length, and short setæ, often barely exceeding the spikelets. Culms very slender, erect, glabrous, cylindrical, simple or somewhat branched at the base; nodes glabrous; sheaths loose, glabrous, shorter than the internodes, not ciliate on the hyaline margins; ligule very short, ciliate; leaf-blades involute-setaceous, 0.5 to 2 dm. long, 1 to 3 mm. wide, smooth or slightly scabrous above, long-acuminate. Panicles cylindrical, dense, 3 to 5 mm. in diameter, branches contiguous, very short, 1-flowered; rachis setose or pubescent; setæ 5 to 8, involucrate, unequal, very short, flexuous, equaling or twice exceeding the spikelet, yellowish, antrorsely scabrous. Spikelets 2 mm. long, ovate, acute; first glume triangular-ovate, acute, 3-nerved, one-third the spikelet in length; second glume one-half as long as the spikelet, ovate, acute, 5-nerved; third glume equaling the flowering glume, 5-nerved, sulcate, subtending a broad-ovate, hyaline palea its own length; flowering glume ovate, acute, abruptly apiculate, transversely undulate-rugose. Palea plane, striate.

Alabama, Florida, Texas, Mexico to South America.

SPECIMENS EXAMINED.—*Alabama:* Mobile, on "ballast" and about wharves, 14 Mohr 1891; 19 Kearney 1895. *Florida:* Apalachicola, on "ballast," Chapman, no date. *Texas:* No locality, Buckley 1888; Nealley 1887, 1888; Corpus Christi, Nealley 1891. *Cuba:* 3473 Wright 1860–64; Reed, no date. *Mexico:* Cordova, 5 Fink 1889–1891; Chihuahua, Palmer 1885; Oaxaca 1907, Nelson 1894.

FIG. 5.—*Chætochloa brevispica: a*, branch showing spikelets and setæ; *b*, spikelet showing the first and third glumes; *c*, flowering glume seen from the back; *d*, anterior view of the flowering glume, showing palea.

B. *Setæ 1–3, not involucrate.*

**Panicle dense cylindrical; branches short, approximate.*

†*Setæ retrorsely scabrous, wholly or in part.*

5. **CHÆTOCHLOA BREVISPICA** nom. nov. *Panicum verticillatum parviflorum* Doell in Mart. Fl. Bras. **2**^{2}: 172. (1877), not *Cenchrus parviflorus* Poir. in Lam. Encycl. **6**: 52 (1804.). (Fig. 5.)

A low, spreading, much-branched annual, 1 to 3 dm. high, with short, cylindrical spikes and lanceolate leaves 3 to 6 cm. long. Culms compressed, geniculate, decumbent, very glabrous; nodes smooth; sheaths very loose, striate, compressed, glabrous, margins smooth, shorter than their internodes; ligule short, densely ciliate-fringed with white hairs; leaf-blades 3 to 6 cm. long, 4 to 8 mm. wide, cordate at the base, long-acuminate at the apex, scabrous and sparingly papillate ciliate on both sides, especially below, margins cartilaginous, serrulate-scabrous. Inflorescence dense, cylindrical, 1 to 3 cm. long, about 1 cm. in diameter, purplish; common axis angular, scabrous; branches very short, subverticillate, densely flowered; setæ 1 or 2, purple, stout, flexuous, retrorserly scabous, 3 to 8 mm. long. Spikelets 1.5 to 2 mm. long, nearly sessile, elliptical-ovate; first glume triangular-ovate, acute or obtuse, 3-nerved, about one-third the length of the spikelet; second glume ovate, obtuse, 5 to 7-nerved, nearly equaling the 5 to 7-nerved, acute third glume, which bears a short palea in its axil; flowering glume about 1.5 mm. long, elliptical-ovate, acute, striate, nearly smooth or very finely transversely wrinkled below. Palea similar in texture and markings, about as long as the glume.

FIG. 6.—*Chætochloa verticillata*: *a*, *b*, views of the spikelet, showing the setæ.

Alabama, Louisiana, Mexico, South America, Europe.

SPECIMENS EXAMINED.—*Louisiana:* Port Eads, Langlois 1885, on "ballast." *Alabama:* Mobile, on "ballast," Mohr 1888. *Mexico:* Guadalajara, 484 Palmer 1886.

Very readily distinguished from *C. verticillata* by its smaller size, more spreading habit, short cylindrical spikes, and smaller spikelets.

6. **Chætochloa verticillata** (L.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. 4: 39 (1897). *Panicum verticillatum* L. Sp. Pl. ed. 2, 82 (1762). *Setaria verticillata* Beauv. Agrost. 51 (1812). *Chamæraphis verticillata* Porter Bul. Torr. Bot. Club. **20**: 196 (1893). *Ixophorus verticillatus* Nash Bul. Torr. Bot. Club. **22**: 422 (1895). (Fig. 6.)

An erect or ascending, glabrous, somewhat cæspitose annual, 3 to 6 dm. high, with linear-lanceolate leaves and interrupted subspiciform panicles 5 to 10 cm. long. Culms geniculate, glabrous, compressed; nodes brown or black, smooth; sheaths loose, shorter than their internodes, smooth, striate, margins glabrous below,

ciliate above; ligule short, hispid-ciliate; leaf-blades flat, soft, 7 to 18 cm. long, 6 to 12 mm. wide, acuminate, abruptly narrowed at the rounded base, scabrous on both sides, serrulate-scabrous on the cartilaginous margins. Panicles spike-like; rachis striate, angular, scabro-hispid; branches subverticillate, short, densely flowered; setæ 1 to 3, stout, flexuous, retrorsely scabrous to the very base, 3 to 6 mm. long. Spikelets nearly sessile, narrowly elliptical-ovate, acute, 2 to 2.5 mm. long; first glume triangular-ovate, acute, 3-nerved, one-third as long as the spikelet; second glume elliptical-ovate, 5 to 7 nerved, mucronate, nearly equaling the 5 to 7 nerved acute third glume and slightly exceeding the flowering glume; third glume subtending a lanceolate, hyaline palea two-thirds its own length; flowering glume about 2 mm. long, narrowly elliptical, rounded at the apex and very shortly apiculate, smooth or with very fine transverse wrinkles below the middle. Palea similar in markings, equaling the glume.

A cosmopolitan weed widely distributed in the eastern United States. Introduced from Europe. July–October.

Specimens examined.—*Massachusetts:* Salem, Conant 1879. *Connecticut:* New Haven, Allen 1879. *Pennsylvania:* Philadelphia, Parker 1877; Stickers, Smith; Easton, Porter 1895. *Delaware:* Wilmington, 145 Commons 1897. *District of Columbia:* Vasey 1886. *Alabama:* Mobile, 14 Mohr 1891. *Kentucky:* Lexington, Short 1835. *Iowa:* Mt. Cyr, 929 Beard 1897; Mt. Pleasant, 773 Mills 1897. *Missouri:* St. Louis, 267 Eggert 1886. *Wisconsin:* Oshkosh, Random 1896.

7. **CHÆTOCHLOA SCANDENS** (Jacq.) n. comb. *Pennisetum scandens* Jacq. Hort. Vindb. (1801). *Setaria scandens* Schrad. in R. & S. Mant. **2**: 279 (1824). *Panicum scandens* Trin. Gram. Pan. 166 (1826).

An erect or ascending cæspitose annual, 4 to 7 dm. high, with geniculate, subcompressed culms, linear-lanceolate leaves, and loose, bristly subspiciform panicles 4 to 12 dm. long. Culms slender, branching at the base, scabrous below the panicle, otherwise glabrous; nodes brown or black, smooth; sheaths loose, striate, compressed, glabrous or slightly scabrous above, about equaling the internodes, margins ciliate above; ligule very short, bearded; leaf-blades linear to linear-lanceolate, spreading, plane, 5 to 16 cm. long, 2 to 5 mm. wide, long-acuminate, abruptly narrowed at the rounded base, scabrous and short strigose-pubescent on both sides, serrulate-scabrous on the cartilaginous margins. Panicle cylindrical, 1 to 1.5 cm. in diameter; rachis striate, densely short-pubescent or pilose; branches short, few-flowered, contiguous, spirally arranged; setæ 1 to 3, generally purplish, flexuous, 1 to 2 cm. long, retrorsely scabrous above, antrorsely scabrous at the base, spreading. Spikelets 1 to 1.5 mm. long, ovate, acute, green or purplish; first glume broadly ovate, acute, 3-nerved, one-half as long as the spikelet and inclosing its base; second and third glumes equaling the flowering glume, 5-nerved, acute, apiculate, the third somewhat sulcate; flowering glume ovate, acute, 1 to 1.5 mm. long, striate, transversely undulate-rugose below, nearly smooth above, the inclosed palea ovate, striate, concave.

West Indies, Central and South America.

Specimens examined.—*Puerto Rico:* 6498 Sintenis 1887, distributed as *Setaria verticillata* Beauv. *Honduras:* 5583 *bis* J. Donnell Smith 1888. *Guatemala:* Buena Vista, 4295 J. Donnell Smith 1892. *Venezuela:* 1144 Fendler 1854–55; 1644, 1856–57. *Brazil:* 4356, 4510 Burchell; 174 Riedl.

Readily distinguished from *C. verticillata* by its smaller spikelets, strigose-pubescent leaves, and longer, irregularly spreading setæ, which are retrorsely scabrous above and antrorsely scabrous at the base.

†† *Setæ antrorsely scabrous.*

‡ *Flowering glume smooth or nearly so.*

§ *Rachis scabrous.*

8. **CHÆTOCHLOA AMBIGUA** (Guss.) n. comb. *Setaria verticillata* var. *ambigua* Guss. Prodr. **1**: 80 (1827). *Setaria ambigua* Guss. Fl. Sic. Syn. **1**: 114 (1842). Not *Setaria ambigua* Schrad. Linnæa **12**: 430 (1838). (Fig. 7.)

A cæspitose, erect, much branched annual, 2 to 5 dm. high, with compressed culms, lanceolate leaves, and rather loose spicate panicles 4 to 10 cm. long. Culms geniculate at the base, glabrous, leafy, the nodes brown, glabrous; sheaths striate, compressed, loose, about equaling the internodes, thin, glabrous, the margin ciliate above; ligule about 1 mm. long, densely ciliate-fringed with white hairs, which are 1 mm. long or less. Leaf-blades lanceolate, cordate at the base, long-acuminate at the apex, 5 to 15 cm. long, 6 to 15 mm. wide, scabrous on both sides and on the cartilaginous margins. Axis of the inflorescence channeled, scabrous, but not pilose; branches short, subverticillate, densely flowered, the lower rather remote; setæ solitary, stout, somewhat flexuous, antrorsely scabrous, 4 to 8 mm. long. Spikelets elliptical, 2 to 2.5 mm. long; first glume triangular-cordate, 3-nerved, clasping the base of the spikelet and about one-third its length; second and third glumes equaling the flowering glume in length, obtuse, 5 to 7 nerved, the third with a palea; flowering glume 2 mm. long, elliptical, rounded at the apex, striate, very finely transversely wrinkled, not rugose. Palea similar in texture and markings.

FIG. 7.—*Chætochloa ambigua*: *a*, spikelet showing seta; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

Collected on "ballast," Camden, N. J., by F. Lamson-Scribner, 1884, and at Mobile, Ala., by Chas. Mohr, 1884.

An adventitious European annual with the habit and inflorescence of *C. verticillata* (L.) Scribner, but readily distinguished from that species by its having the setæ antrorsely instead of retrorsely scabrous. Distinguished from *C. viridis* (L.) Scribner, by its loose, subverticillate panicles and scabrous, not pilose, rachis.

§ § *Rachis pilose.*

9. **Chaetochloa viridis** (L.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 39 (1897). *Panicum viride* L. Sp. Pl. ed. 2, 83 (1762). *Setaria viridis* Beauv. Agrost. 51 (1812). *Chamæraphis viridis* Porter Bul. Torr. Bot. Club. **20**: 196 (1893). *Ixophorus viridis* Nash Bul. Torr. Bot. Club. **22**: 423 (1895). (Fig. 8.)

An erect, glabrous, cæspitose annual, 2 to 9 dm. high, with short, lanceolate leaves and dense, cylindrical, spike-like green panicles 2 to 10 cm. long. Culms usually much branched at the base, glabrous, compressed; nodes smooth; sheaths compressed, loose, longer than the internodes, ciliate on the margins; ligule short, ciliate with long, white hairs; leaf-blades 0.5 to 2.5 dm. long, 4 to 10 mm. wide, scarcely narrowed at the cordate base, long-acuminate, slightly scabrous on both sides or sometimes nearly glabrous, serrulate-scabrous on the cartilaginous margins. Panicles linear-ovate in outline, tapering to the obtuse apex; rachis striate, villous, generally about 1 cm. in diameter, exclusive of the bristles; setæ slender, strict, spreading, antrorsely scabrous, 1 to 1.5 cm. long, green or rarely purplish. Spikelets about 2 mm. long, elliptical; first glume triangular-ovate, 3-nerved, about one-third the spikelet in length; second and third glumes elliptical, obtuse, 5-nerved, equaling the spikelet, the third glume subtending a lanceolate, hyaline palea one-third its own length; flowering glume elliptical, rounded at the apex, finely and faintly transversely wrinkled below, or only striate and pitted, the inclosed palea equaling it in length, similar in texture and markings.

In waste places and cultivated grounds throughout North America. Naturalized from Europe. July–September.

FIG. 8.—*Chætochloa viridis*: *a*, branch showing spikelet and setæ; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

SPECIMENS EXAMINED.—*Newfoundland:* Waghorne 1892. *Ottawa:* Macoun 1894, Fletcher 1891. *Maine:* Auburn, Merrill 1897. *New Hampshire:* Peterboro, 236 Robinson 1897. *Connecticut:* 26 Wilson 1892. *New York:* Union Springs, 37 Dudley; Oxford, Coville 1884. *Pennsylvania:* Easton, Porter 1887; Harrisburg, Small 1888; Philadelphia, Smith. *Delaware:* Stanton, 147 Commons 1897. *District of Columbia:* Blanchard 1891, 532 Pollard 1895, Topping 1895. *Ohio:* Rickseeker 1894. *Michigan:* Clifton, 629 Farwell. *Tennessee:* Knoxville, Scribner. *Iowa:* Battle Creek, 956 Preston 1897; Fayette Co., 273 Fink 1894; Carnarvon, 291 Pammel 1896; Clinton, 268 Ball 1895; Des Moines, 28 Ball 1898; Manchester,

1007 Ball 1897. *Kansas:* Riley, 576 Norton 1895; Syracuse, 129 Thompson 1893; Hooker Co., 1568 Rydberg 1893; Wiegand, 2684 Clements 1893; Central City, 262 Shear 1895, 2009 Rydberg 1895; Kearney, Holmes 1889. *Wisconsin:* Oshkosh, Random 1896; Newbold, 1701 Cheney 1893. *South Dakota:* Aberdeen, 123 Griffiths 1896; Redfield, 208 Griffiths 1897. *Missouri:* St. Louis, 268 Eggert. *Colorado:* Thomas 1869, 510 Jones 1878; Colorado Springs, 2158 Williams 1896; Glenwood Springs, 1304 Shear & Bessey 1898. *Utah:* 6034 Jones 1894; Caineville, 5696*b* Jones 1894. *Oregon:* Milton, 33 Brown 1896. *North Carolina:* Magnetic City, 9 Wetherby 1895. *Alabama:* Tuskegee, 15 Carver 1897. *Mississippi:* Ocean Springs, 1 Forkert 1898. *Texas:* Kerrville, Nealley 1899, Heller 1894. *New Mexico:* Mesilla, 89 Wooton 1897. *Arizona:* Verde Valley, 532 McDougal 1891. *Mexico:* 349 Liebmann 1841–1843.

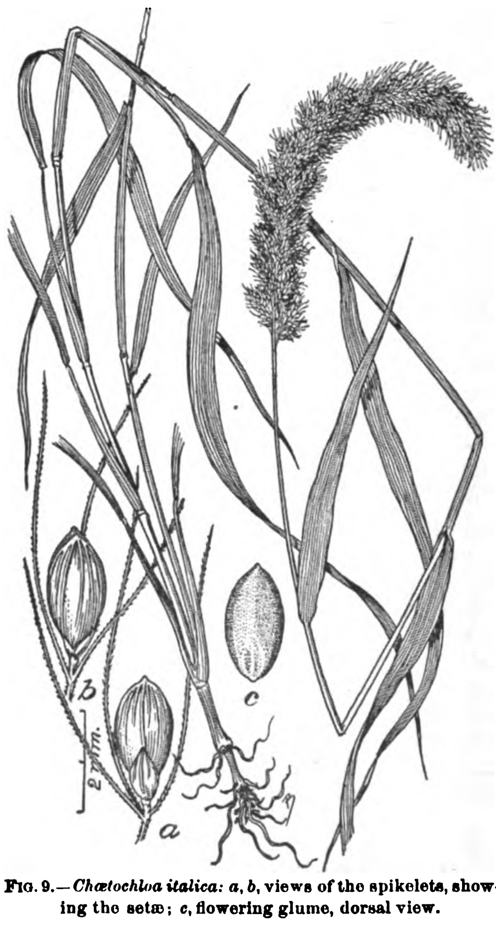

FIG. 9.—*Chætochloa italica:* *a*, *b*, views of the spikelets, showing the setæ; *c*, flowering glume, dorsal view.

10. Chætochloa italica (L.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 39 (1897). *Panicum italicum* L. Sp., Pl. 56 (1753). *Setaria italica* Beauv. Agrost. 51 (1812) *Chamæraphis italica* Kuntze Rev. Gen. Pl. **2**: 768 (1891). *Ixophorus italicus* Nash Bul. Torr. Bot. Club **22**: 423 (1895). (Fig. 9.)

A stout, erect, somewhat glaucous annual, with broad leaves and large, dense, compound, spiciform panicles 8 to 20 cm. in length. Culms simple or branching at the base, 3 to 8 mm. in diameter below, glabrous or slightly scabrous below the nodes and panicle; nodes bearded with short appressed hairs; sheaths loose, striate, glabrous or somewhat scabrous, subcompressed, generally exceeding the internodes, ciliate on the margins; ligule short, densely ciliate-fringed with white hairs 2 to 3 mm. long; leaf-blades lanceolate, narrowed at the base, long-acuminate, 2 to 4 dm. long, 1.5 to 3 cm. wide, scabrous on both sides, serrulate-scabrous on the cartilaginous margins. Panicles dense, cylindrical, green, becoming yellow at maturity, 2 to 3 cm. in diameter, obtuse or truncate at both ends, sometimes interrupted below; rachis densely villous, branches 1 to 2 cm. long, contiguous, densely flowered; setæ 1 to 3, green or purplish, 3 to 10 mm. long, often shorter than the spikelets or nearly obsolete, antrorsely scabrous. Spikelets elliptical, strongly convex, 2.5 to 3 mm. long, obtuse; first glume one-fourth to one-half as long as the spikelet, acute, 1 to 3 nerved; second and third glumes about equaling the flowering glume, 5 to

7 nerved; flowering glume glossy, nearly smooth or finely and faintly transverse-rugose or pitted, striate; the inclosed palea similar in markings, slightly convex.

Widely cultivated and often an escape in fields and waste places; very variable. Quebec to Minnesota, south to Florida and Texas. Native of Europe and Asia. July–September.

Chætochloa italica germanica (Mill.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **6**: 32 (1897). *Panicum germanicum* Mill. Gard. Dict., ed. 8, 1 (1768). *Setaria germanica* Beauv. Agrost. 51 (1812).

A smaller form, 2 to 6 dm. high, with slender culms, usually branching at the base; leaves 0.5 to 2 dm. long, 5 to 10 mm. wide, scabrous. Panicles dense, cylindrical, obtuse at the apex, usually tapering at the base, green or purplish, 5 to 10 cm. long, about 1 cm. in diameter; setæ purple, rarely green, 5 to 15 mm. long, much exceeding the spikelets. Flowering glume green or purplish, when green, usually more or less blotched with purple.

Like *C. italica*, this variety is widely cultivated in this country under the name of Hungarian grass or millet, with about the same range as the type; often escaped from cultivation in fields and waste places. Some forms of this grass can scarcely be distinguished from *C. viridis* (L.) Scribn., and it is probably only a form of that species changed by cultivation and intermediate between *C. viridis* and *C. italica*.

11. **Chætochloa magna** (Griseb.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 39 (1897). *Setaria magna* Griseb. Fl. Brit. W. Ind. 554 (1864). *Chamæraphis magna* Beal. Grasses of N. Am. **2**: 152 (1896). (Fig. 10.)

FIG. 10.—*Chætochloa magna*: *a*, branch showing spikelet and setæ; *b*, view of the spikelet; *c*, flowering glume; *d*, anterior view of the flowering glume, showing palea.

A coarse, stout, erect perennial (?) 10 to 36 dm. high, with cylindrical culms 0.5 to 2 cm. thick at the base, linear-lanceolate leaves and dense, cylindrical panicles 1.5 to 3 dm. long. Culms branching at the base, glabrous or slightly scabrous below the smooth nodes; sheaths loose, spreading, striate, compressed, glabrous, scabrous on the keel, margins smooth and hyaline below, densely ciliate-fringed above; ligule very short, ciliate-fringed with white hairs; leaf-blades 3 to 6 dm. long, 1 to 3 cm. wide, long attenuate-pointed, gradually narrowed to the base, scabrous on both sides, serrulate-scabrous on the cartilaginous margins. Panicles green, virgate, generally interrupted below, 2 to 5 cm. in diameter; rachis striate, densely pilose, branches 1 to 5 cm. long, strict, densely flowered, contiguous, much exceeding their internodes, or the lower rather remote; setæ 1 to 3, green,

slender, antrorsely scabrous, 8 to 11 mm. long. Spikelets elliptical, acute, 2 mm. long; first glume broadly ovate, acute or obtuse, 3 to 5-nerved, inclosing the base of the spikelet; second glume equaling the spikelet, short-apiculate, 5 to 9-nerved; third glume 5-nerved, slightly sulcate, subtending an ovate, hyaline palea nearly its own length; flowering glumes elliptical-ovate, acute, short-apiculate, nearly 2 mm. long, very smooth, glossy, not striate or rugose, the inclosed palea equaling the glume, very smooth.

Low grounds and marshes, often in shallow water, Delaware to Florida, Louisiana, and western Texas, Bermuda, West Indies, Central America.

SPECIMENS EXAMINED.—*Delaware:* Collins Beach, 148 Commons 1892; Woodland Beach, 148*a* Commons 1892; *District of Columbia:* Cultivated, Vasey 1889; *Virginia:* Smiths Island, Palmer 1897; *Florida:* Curtiss 1885; Merrits Island, Indian River, 3618 Curtiss 1879; Apopka, 21 Baker 1897; Fort Ogden, Lowe 1892; Deland Co., Hill 1899; Grasmere, 1054 Combs & Baker, 1898; Barstow, 1219 Combs 1898; Homosassa, 464 Combs 1898; Eustis 1279 Nash 1894; *Louisiana:* Pointe-à-la-Hache, 56 Langlois 1879; *Texas:* 801 Wright 1849; *Bermuda:* Munro 1864; *Costa Rica:* 6825 Pittier 1892.

‡‡ *Flowering glume transversely undulate-rugose.*

† *Rachis very densely pilose.*

12. **CHÆTOCHLOA LONGIPILA** (Fourn.) n. comb. *Setaria longipila* Fourn. Mex. Pl. Enum. Gram. 47 (1886).

An erect, somewhat cæspitose, glabrous annual, 3 to 5 dm. high, with slender culms, short, lanceolate leaves and somewhat exserted, green, subspiciform panicles 2 to 7 cm. in length. Culms glabrous, except below the panicle, branching at the base; nodes brown, bearded with appressed hairs; sheaths slightly compressed, striate, glabrous, much shorter than the internodes, ciliate on the margins, slightly bearded at the apex; ligule short, ciliate-fringed with long white hairs; leaf-blades 5 to 10 cm. long, 5 to 10 mm. wide, tapering to the base and to the acute or acuminate apex, scabrous on the upper side and on the cartilaginous margins, nearly smooth beneath. Panicles about 6 mm. in diameter, interrupted, the branches short, few-flowered; rachis densely pilose-pubescent, with long, erect, white hairs extending a short distance below the panicle; setæ 1 to 3, green, stout, antrorsely scabrous, flexuous, 3 to 5 mm. long. Spikelets ovate-globose, acute, about 1.7 mm. long; first glume about one-half as long as the spikelet, triangular-ovate, acute, 3-nerved, slightly inclosing the base of the spikelet; second glume equaling the flowering glume, strongly convex, 5-nerved; third glume slightly exceeding the flowering glume and somewhat inclosing it, 5-nerved, apiculate, subtending a broadly-ovate, hyaline palea of nearly its own length; nerves in all the glumes green, prominent; flowering glume strongly convex, broadly ovate, acute, strongly transversely undulate-rugose, the inclosed palea striate, strongly convex at the base, concave above, equaling the glume in length.

Mexico. August.

SPECIMENS EXAMINED.—2017 Rose 1897, foothills of the Sierra Madre Mountains, Territorio de Tepic, between Agnacato and Dolores.

This species has much the same habit as *C. liebmanni pauciflora*, but is at once disguished from that and other related forms by its small, ovate, globose spikelets and remarkably dense pilose-pubescent rachis.

†† *Rachis thinly pilose.*

= *Leaves scabrous.*

13. **Chætochloa corrugata** (Ell.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 39 (1897). *Panicum corrugatum* Ell. Sk. Bot. S. Car. & Ga. **1**: 113 (1817). *Setaria*

corrugata R. & S. Mant. **2**: 276 (1824). *Chamæraphis corrugata* Kuntze Rev. Gen. Pl. **2**: 770 (1891). (Fig. 11.)

A rather stout, erect or ascending cæspitose annual, 6 to 10 dm. high, with elongated, spike-like panicles and linear-lanceolate, scabrous leaves. Culms compressed, striate, scabrous below the nodes and panicle, otherwise smooth, much branched at the base, often geniculate and rooting at the lower nodes; nodes brown, bearded with short appressed hairs; sheaths very loose, compressed, keeled, the lower ones usually much exceeding the internodes, scabrous or sometimes nearly smooth, rarely pubescent, smooth or ciliate on the margin; ligule fringed with rather rigid white hairs; leaf-blades 1 to 3 dm. long, 3 to 6 mm. wide, scabrous on both sides, serrulate-scabrous on the cartilaginous margins, tapering to the base, acuminate-pointed. Panicles cylindrical, dense, narrowed to the obtuse apex, 6 to 16 cm. long, 6 to 15 mm. in diameter below, exclusive of the setæ; rachis angular, pilose; branches short, contiguous, densely 5 to 15 flowered; setæ 1 or rarely 2 at each spikelet, green or purplish, erect-spreading, flexuous, 5 to 15 mm. long, antrorsely scabrous. Spikelets ovate, acute, about 2 mm. long, gibbous; first glume one-third to one-half as long as the spikelet, ovate-cordate, acute, 3 to 5 nerved, inclosing the base of the spikelet; second glume broadly ovate, acute or obtuse, apiculate, about four-fifths as long as the spikelet, 5 to 7 nerved, the mid-nerve excurrent, the lateral ones anastomosing or abruptly vanishing in the hyaline margin; third glume equaling and slightly inclosing the flowering glume, sulcate, 5-nerved, subtending a lanceolate, hyaline palea, nerves in all the glumes green, prominent; flowering glume ovate, acute, convex, very strongly transversely undulate-rugose for its whole length; the inclosed palea transversely striate, slightly convex at the base, plane above.

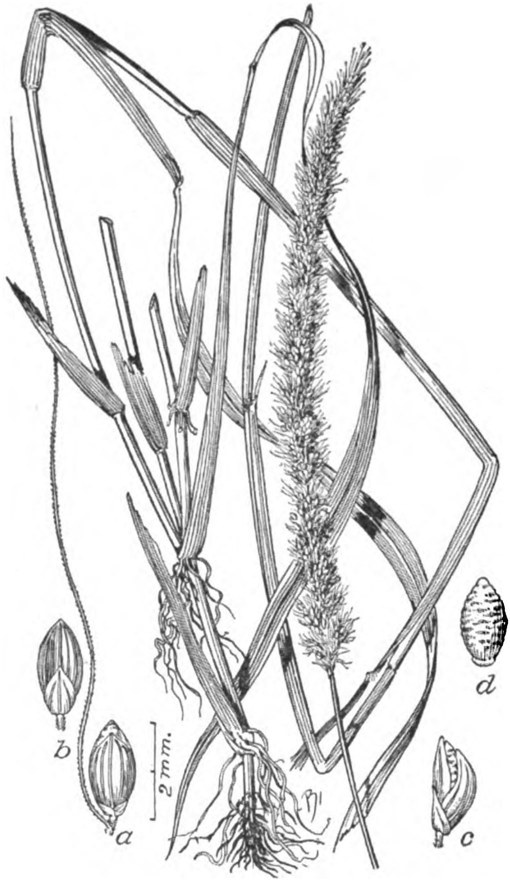

FIG. 11.—*Chætochloa corrugata: a*, spikelet showing seta; *b, c*, views of the spikelet; *d*, flowering glume, dorsal view.

In waste places, cultivated fields, etc., Georgia to Florida. July–October.

SPECIMENS EXAMINED.—*Florida:* Jacksonville, 3616 Curtiss; no locality, Chapman; Duval Co., 328 Fredholm 1893; Apalachicola, 108 Kearney 1895; Anastasia Island, 175 Kearney 1895; Grasmere, 1047 Combs & Rolfs 1898; Cedar Key, 795 Combs 1898; Orange, Baker 1897; Homosassa, 944 Combs 1898.

CHÆTOCHLOA CORRUGATA PARVIFLORA (Poir.) n. comb. *Cenchrus parviflorus* Poir. in Lam. Encycl. 6: 52 (1804). *Setaria ventenatii* Kunth Rev. Gram. 1: 251. t. 37 (1829). *Panicum glaucum purpurascens* Ell. Sk. Bot. S. Car. & Ga. 1: 113 (1817). (Fig. 12.)

A more slender form 2 to 7 dm. high, much branched from the base, leaves shorter, panicles exserted, 2 to 7 cm. long, branches few-flowered, setæ spreading, green or purple; spikelets as in the type.

In fields and waste places, South Carolina to Florida, West Indies. April–October.

SPECIMENS EXAMINED.—Specimen in Herb. Phil. Acad. Sci., collected by Elliot, South Carolina or Georgia. *Florida:* Indian River, Curtiss 1879; Jacksonville, 5124 Curtiss 1894; 4041 Curtiss 1893; without locality, Curtiss 1885; Vesterand 1889; Duval Co., 187 Fredholm 1893, Eustis 640, 1382 Nash 1894; Lake City, 140 Combs & Rolfs 1898; Gainesville, 721, 723 Combs 1898; Homosassa, 945 Combs 1898; Barstow, 1177 Combs 1898; Old Town, 865 Combs 1898; Dunnellon, 914*a* Combs 1898; Manatee Co., 1287, 1292 Combs 1898; Miami, 253 Pollard 1898.

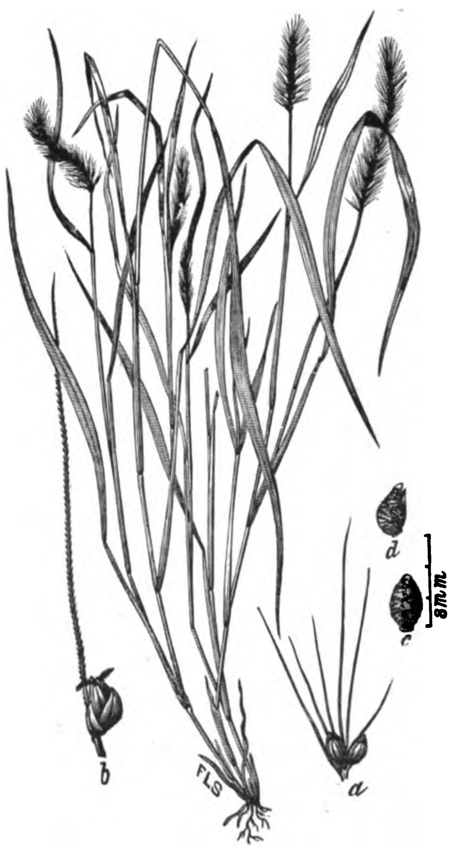

FIG. 12.—*Chætochloa corrugata parviflora: a*, branch showing two spikelets and setæ; *b*, spikelet; *c, d*, views of the flowering glume.

== *Leaves pilose or pubescent.*

14. **CHÆTOCHLOA GIBBOSA** sp. nov.

An erect, densely cæspitose, pubescent perennial, 4 to 7 dm. high, with rather loose, cylindrical, exserted panicles, compressed sheaths, and linear-lanceolate leaves, which are strongly pilose on both sides with long spreading white hairs. Culms slender, smooth, cylindrical; nodes brown or black, smooth; sheaths loose, striate, smooth, the margin densely ciliate with long erect white hairs, bearded at the apex; ligule brown, about 1 mm. long, densely ciliate-fringed with white hairs 3 or 4 mm. long; leaf-blades 1 to 2.5 dm. long, 5 to 7 mm. wide, abruptly rounded at the base, long-acuminate, scabrous on both sides and on the cartilaginous margins. Panicle 5 to 7 cm. long, loose, branches very short, few-flowered; setæ 1 or 2 at each spikelet, spreading-erect, flexuous, 8 to 15 mm. long, antrorsely scabrous. Spikelets ovate-globose, 2 mm. long, acute; first glume nearly one-half as long as the spikelet, broadly ovate-cordate, obtuse, apiculate, 5-nerved, inclosing the base of the spikelet; second glume broadly ovate, obtuse, abruptly apiculate, 5 to 7 nerved, about four-fifths as long as the spikelet; third glume equaling and slightly inclosing the flowering glume, 5-nerved, plane, subtending a lanceolate, hyaline palea; flowering

glume strongly gibbous, acute, short-apiculate, transversely undulate-rugose, except at the nearly smooth base and apex, the inclosed palea broadly elliptical-ovate, very strongly convex, transversely striate.

Type specimen in Gray Herbarium Cambridge, No. 528 (828?), "Herbarium Berlandierianum Texano-Mexicanum," no locality or date.

A very distinct species, readily recognized by its broad-linear, pilose leaves, densely bearded sheath-margins and ligule, long first glume, and strongly convex palea.

15. **CHÆTOCHLOA HISPIDA** sp. nov. (Fig. 13.)

A simple or sparingly branched, erect, somewhat hirsute annual, about 6 dm. high, with linear-lanceolate leaves and exserted, cylindrical, spike-like panicles about 6 cm. long. Culm slender, compressed below, somewhat geniculate, striate, scabrous below the panicle, thinly pilose for its whole length with scattered white hairs; nodes bearded with appressed hairs; sheaths compressed, striate, strigose with rather long white hairs, especially above and on the margins; ligule short, ciliate; leaf-blades 10 to 15 cm. long, 4 to 6 mm. wide, tapering to the base, acuminate, scabrous on both sides and margins, papillate-pilose on the nerves on both sides, mid-nerve very prominent on the lower side, smooth. Panicle densely flowered, about 7 mm. in diameter exclusive of the setæ; rachis angular, pilose; branches short, contiguous, 1 to 3 flowered; setæ 1 or 2, green, spreading, 8 to 12 mm. long, antrorsely scabrous above, nearly smooth at the base; first glume nearly one-half as long as the spikelet, broadly ovate-cordate, acute, apiculate, 3-nerved, inclosing the base of the spikelet; second glume broadly-ovate, obtuse, about four-fifths as long as the spikelet, short-apiculate, 7-nerved, the mid-nerve excurrent, the lateral ones vanishing; third glume equaling the flowering glume, sulcate, 5-nerved, subtending a lanceolate, hyaline palea; flowering glume elliptical-ovate, acute, strongly gibbous, transversely undulate-rugose, the inclosed palea convex at the base, plane above.

FIG. 13.—*Chætochloa hispida:* *a*, spikelet showing seta; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

In sandy pine woods, Cuba. Type specimen in the Gray Herbarium, Cambridge, collected by C. Wright in January, 1865; no number.

Related to *C. corrugata* (Ell.) Scribn., but readily distinguished by its more simple habit,

hirsute sheaths, pubescent leaves, and strongly rugose flowering glumes. This specimen is cited by Grisebach, Plant. Cub. 234 (1866), under *Setaria glauca imberbis.*

16. **CHÆTOCHLOA LEUCOPILA** sp. nov. (Fig. 14.)

A densely cæspitose, erect perennial, 2.5 to 4 dm. high, with narrow, involute leaves and rather loose, narrow panicles 3 to 6 cm. in length. Culms very slender, much branched at base, striate, scabrous or scabro-pubescent below the nodes and panicle, otherwise smooth; nodes brown, the lower ones densely bearded with long white hairs, the hairs on upper nodes shorter, sheaths loose, compressed, glabrous or usually slightly scabrous on the keel, margins nearly smooth below, densely ciliate-fringed with long white hairs above; ligule brown, very short, densely ciliate with spreading white hairs 3 to 5 mm. long; basal leaves numerous, those of the culms 1 or 2, linear, 5 to 10 cm. long, 2 to 4 mm. wide, rather soft, becoming involute-setaceous, densely bearded at the throat with spreading white hairs, which equal or exceed those of the ligule, the upper surface pilose with long white hairs, the lower surface smooth or only slightly scabrous. Panicle somewhat exserted, about 6 mm. in diameter, pale, few-flowered; axis undulate, angular, scabro-pubescent, branches 2 mm. long or less; setæ single or in pairs, green, flexuous, antrorsely scabrous, 2 to 5 mm. long. Spikelets oblong-ovate, acute, 3-nerved, barely 2 mm. long; first glume triangular-ovate, acute, 3-nerved, one-third as long as the spikelet; second glume broadly ovate, obtuse, apiculate, 5-nerved, two-thirds to three-fourths as long as the flowering glume; third glume equaling the flowering glume, 5-nerved, subtending a hyaline, lanceolate palea two-thirds its own length; flowering glume narrowly ovate, acute, apiculate, nearly smooth, striate and pitted below, not rugose, nearly smooth, shining at the apex, the inclosed palea broadly lanceolate, pitted, slightly convex for its whole length.

FIG. 14.—*Chætochloa leucopila*: *a*, spikelet showing seta; *b*, *c*, views of the spikelet; *d*, anterior view of the flowering glume, showing the sterile and fertile palea; *e*, flowering glume, dorsal view.

Mexico. Type specimen collected at Parras, State of Coahuila, Mexico, 1363 E. Palmer, June, 1880.

At once distinguished by its densely cæspitose habit, narrow leaves, densely bearded ligule, and pilose sheath margin, and leaves.

** *Panicle loose, interrupted; branches more or less elongated.*

† *Branches densely flowered.*

‡ *Setæ both antrorsely and retrorsely scabrous.*

17. **CHÆTOCHLOA ONURUS** (Griseb.) n. comb. *Setaria onurus* Griseb. Fl. Brit. W. Ind. 555 (1864). *Panicum onurum* Willd. in Herb., ex Griseb.

A stout, erect, glabrous perennial, 2 to 10 dm. high, with virgate, interrupted panicles and linear-lanceolate leaves, 1.5 to 4 dm. long. Culms glabrous, erect, simple or sparingly branched at the base, cylindrical; nodes glabrous; sheaths compressed, strigose-pubescent, sometimes slightly scabrous on the keel, the lower ones much longer than the internodes, imbricate, ciliate on the margins, bearded at the apex; ligule short, ciliate; leaf-blades 10 to 15 mm. wide, scabrous on both sides and on the cartilaginous margins, long-acuminate at the apex, tapering at the base, midvein prominent throughout. Panicle loose, cylindrical, 1 to 2 dm. long, 1.5 to 2 cm. in diameter; rachis striate, pilose; branches spreading-erect, the lower 1.5 to 2 cm. in length, scabrous, equaling or exceeding their internodes; setæ mostly solitary, rarely 2 or 3 at each spikelet, slender, flexuous, 1.5 to 2 cm. long, both antrorsely and retrorsely scabrous. Spikelets ovate-globose, acute, 2 mm. long; first glume one-third as long as the spikelet, triangular-cordate, acute, abruptly apiculate, 5-nerved; second glume one-half to two-thirds as long as the spikelet, broadly ovate, obtuse or truncate, apiculate, 9 to 11 nerved; third glume equaling the flowering glume, thin, 9-nerved, subtending an ovate hyaline palea nearly its own length; flowering glume ovate-globose, acute, generally abruptly apiculate, transversely undulate-striate below, smooth near the apex. Palea similar in markings, strongly convex.

West Indies, Mexico, South America.

Specimens examined.—*Jamaica:* March, spikelets from specimens cited by Grisebach (Fl. Brit. W. Ind. 555) sent from Kew Herbarium, also specimen in the Gray Herbarium. *Cuba:* 3474 Wright 1860, 1864, 3887 Wright 1865; Cienguita, 264 Combs 1895.

In habit very much resembling *C. macrostachya*, but readily distinguished from this and other related forms by its 9 to 11 nerved second glume and both antrorsely and retrorsely scabrous setæ.

‡‡ *Setæ antrorsely scabrous only.*

§ *Leaves linear, glaucous.*

18. **Chætochloa composita** (H. B. K.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. 4: 39 (1897). *Setaria composita* H. B. K. Nov. Gen. & Sp. Pl. 1: 111 (1815). (Fig. 15.)

A pale, glaucous, cæspitose perennial, 3 to 10 dm. high, much branched from the base, with long, linear leaves and cylindrical, dense, or more or less interrupted spike-like panicles 5 to 16 cm. long, 6 to 15 mm. in diameter, exclusive of the setæ. Culms geniculate at the base, subcompressed, scabrous and often pubescent, especially below the nodes, rarely glabrous, the innovations usually short and sterile; nodes bearded with a ring of silky, appressed hairs; sheaths striate, compressed, slightly scabrous on the keel above, and pilose at the apex, otherwise glabrous, the lower sometimes pubescent, mostly shorter than the internodes, ciliate on the margins; ligule very short, densely ciliate-fringed with silky hairs 1.5 to 3 mm. long; leaf-blades linear, plane, 1 to 2.5 dm. long, 2 to 5 mm. wide, glaucous, long, narrow, acuminate at the apex, scabrous on both sides or sometimes nearly glabrous, midvein prominent below, obscure above. Panicle pale green; rachis angular, striate, pilose; branches short, densely flowered, contiguous, crowded or sometimes rather remote, especially below; setæ single, rarely in pairs, green, flexuous, 5 to 15 mm. long, antrorsely scabrous.

Spikelets short-pedicellate, narrowly ovate, acute, 2 or rarely 3 mm. long; first glume acute or acuminate, 3-nerved, one-half as long as the spikelet; second glume broadly ovate, acute or apiculate, 5-nerved, nearly equaling the spikelet in length; third glume similar to the second, 5-nerved, equaling the flowering glume, subtending a lanceolate, hyaline palea; glumes pale, with prominent green nerves; flowering glume narrowly ovate, acute, short-apiculate, striate, nearly smooth, obscurely transversely wrinkled below, the inclosed palea similar in texture and markings, convex.

Colorado to Arizona, Texas, Mexico, and South America. June–October.

Fig. 15.—*Chætochloa composita*: spikelet showing seta, two views of the spikelet, and dorsal view of the flowering glume.

Specimens examined.—*Colorado:* Canyon City, 780 Jones 1878, 4 Eastwood 1892, 979 Shear 1896. *Arizona:* No locality, Palmer 1869, Vasey 1889, 19, 21 Emersley 1890; Bisbee, 858, 926 Mearns 1892; Tucson, Pringle 1884, 805 Toumey 1892, 77 Toumey 1894; Gila Valley, 334 Rothrock 1874; Fort Verde, 939 McDougal 1891; Fort Huachuca, Wilcox 1894. *New Mexico:* No locality, 2094 Wright 1851–52; Mesilla, 60 Wooton 1897; Rincon, 41, 44*a*, 63 Jones 1884; Albuquerque, 85 Tracy 1887; Las Cruces, Vasey 1881; Mangos, Metcalfe 1897, Smith 1896. *Texas:* No locality, Nealley 1877; Western Texas, 799 Wright 1849; Maranillas, Havard 1883; Mesquite Bay, Ravenel 1869; Pinto Creek, Kinney Co., 83 Hall 1895; San Diego, Smith 1897; Painted Cave, Val Verde Co., 115 (in part) Nealley 1892. *Mexico:* Guaymas, 340 Palmer 1887; San Bernardino ranch, Mexican boundary, 746, 771, 781 Mearns 1892; San Luis Mountains, 2101 Mearns 1893; White Water, 2313 Mearns 1893.

This common southwestern grass has been variously referred by American authors and collectors to *Setaria caudata* and *Setaria setosa*, but is at once distinguished from these species by its pale aspect, cylindrical panicle, long glaucous leaves, and long first and third glumes. *Setaria caudata* in Bul. No. 12, Div. Bot. U. S. Dept. Agr., "Grasses of the Southwest," pl. 5 (1891), and in "Bot. of Western Texas," Contr. U. S. Nat. Herb. **2**: 510 (1894), *Chamæraphis caudata* in Beal Grasses of N. Am. **2**:157 (1896).

§§ *Leaves linear-lanceolate, green.*

19. **CHÆTOCHLOA MACROSTACHYA**[1] (H. B. K.) n. comb. *Setaria macrostachya* H. B. K. Nov. Gen. & Sp. Pl. 1: 110 (1815). (Fig. 16.)

An erect or ascending perennial, 6 to 12 dm. high, with rather dense cylindrical panicles and linear-lanceolate leaves 1.5 to 5 dm. in length. Culms rather stout, compressed and more or less branched below, striate, scabrous below the nodes and panicle, otherwise smooth; nodes glabrous, sheaths loose, striate, glabrous, usually exceeding the internodes, scabrous on the keel, bearded at the apex, margins ciliate-fringed; ligule fringed with straight white hairs, 3 to 4 mm. long; leaf-blades rigid, linear-lanceolate, scarcely narrowed at the base, gradually tapering to the long acuminate apex, 1 to 1.5 cm. wide, scabrous on both sides or rarely nearly smooth, generally with a few long white hairs toward the base, midvein prominent throughout. Panicle pale green, strict, thyrsoid, cylindrical, usually tapering to the apex, 1 to 3 dm. long, 1 to 2 cm. in diameter; common axis angular, sparingly villous; branches short, contiguous, densely flowered, erect, exceeding their internodes, the lower generally slightly remote; setæ solitary or in pairs, slender, flexuous, antrorsely scabrous, 1 to 2 cm. in length. Spikelets ovate-globose, about 2 mm. long, acute; first glume one-third to one-half as long as the spikelet, broadly ovate, acute, inflated, and inclosing the base of the spikelet, 3 to 5 nerved; second glume two-thirds to three-fourths as long as the spikelet, broadly ovate, obtuse, apiculate, 5 to 7 nerved; third glume equaling the spikelet, slightly inclosing it by its infolded margins, sulcate, 5-nerved, subtending a lanceolate, hyaline palea about its own length; flowering glume strongly convex, apiculate, striate, and rather prominently transversely undulate-rugose, especially below, the inclosed palea equaling it in length, striate, nearly plane.

FIG. 16.—*Chætochloa macrostachya: a*, spikelet showing the seta; *b, c*, views of the spikelet; *d*, flowering glume, dorsal view.

Texas to Mexico and South America.

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[1] CHÆTOCHLOA AUSTRALIENSIS sp. nov.
A stout, erect, or ascending grass, with lanceolate leaves and rather dense panicles 1.5 to 2 dm. long. Culms glabrous, except below the nodes and panicles; ligule

SPECIMENS EXAMINED.—*Texas:* Laredo, Havard 1884; no locality, Nealley 1887, 1888. *Mexico:* Mirado, 362 Liebmann 1841, cited by Fourn. Mex. Pl. Enum. Gram. 45; Guaymas, 53 E. Palmer 1887; no locality, 378, 505, and 872 E. Palmer.

A distinct species, readily distinguished from *C. composita* (H. B. K.) Scribn. by its gibbous spikelets and broader, lanceolate leaves; and from other related species by its dense subcylindrical panicles.

20. **CHÆTOCHLOA RIGIDA** sp. nov.

An erect, rigid perennial, 3 to 6 dm. high, with loose, narrow, interrupted panicles, few short setæ, and rigid, lanceolate leaves 1 to 2.5 dm. long. Culms cylindrical, somewhat branching below, striate, smooth, scabro-pubescent below the panicles and sometimes below the glabrous nodes; sheaths mostly close, equaling or exceeding the nodes, glabrous, the lower ones imbricate and scarcely striate, margins very smooth, not ciliate; ligule very short, sparingly ciliate, not exceeding 1 mm. in length; leaf-blades rigid, 6 to 12 mm. wide, minutely scabrous on both sides or nearly smooth, often minutely pubescent at the throat, serrulate-scabrous on the margins, narrowed at the base, acuminate, sometimes somewhat involute-setaceous above, midnerve very prominent on the lower side of the leaf for two-thirds its length, glabrous. Panicle 0.5 to 2 dm. long, strict, often scarcely exserted from the upper sheath, pale or straw-colored; rachis angular, short pubescent or somewhat villous, undulate; branches very short or nearly obsolete, the lower not exceeding 1 cm., erect; setæ solitary, often nearly obsolete, stout, flexuous, 3 to 10 mm. long. Spikelets 2 to 2.5 mm. long, ovate, acute; first glume about one-half as long as the spikelet, acute, 3-nerved, the midnerve excurrent, the lateral ones anastomosing with it; second glume one-half to two-thirds as long as the spikelet, 5 to 7 nerved, broadly ovate, acute, apiculate; third glume equaling the flowering glume and slightly inclosing it with its infolded margins, 5-nerved, sulcate, subtending a lanceolate, hyaline palea two-thirds its own length; flowering glume ovate, acute, apiculate, obscurely keeled, striate, transversely undulate-rugose below, nearly smooth and glossy at the apex, the inclosed palea similar in markings and texture, nearly plane.

Lower California. September–February.

SPECIMENS EXAMINED.—*Lower California:* La Paz, 125 E. Palmer 1890 (type); Carmen Island, 857 Palmer 1890; San José del Cabo, 28 Brandegee 1890.

All these plants were distributed under the names of *Setaria caudata* and *S. setosa*, from both of which this species is very distinct. Readily distinguished by its rigid culms, smooth sheaths, narrow, straw-colored panicles, and few, usually very short, setæ. Related to *C. macrostachya.*

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densely bearded with stiff hairs; leaves 2 to 3 dm. long, 1.5 to 2 cm. wide; nodes smooth. Panicle about 2 cm. in diameter; rachis scabrous, sparingly villous; setæ solitary, erect-spreading, 1 to 1.5 cm. long. Spikelets 3 mm. long, narrowly ovate, acute; first glume one-third to one-half as long as the spikelet, acute, 3 to 5-nerved; second glume four-fifths as long as the spikelet, acute, apiculate, 7-nerved, nerves prominent; third glume equaling the spikelet, 5-nerved, subtending a broad-lanceolate, hyaline palea its own length; flowering glume acute, apiculate, strongly transversely undulate-rugose below, nearly smooth at the apex, the inclosed palea striate. In the specimen examined the flowering glume has a prominent hippocrepiform scar at the base.

Australia.

A species previously referred to *C. macrostachya* (H. B. K.), but from which it is at once distinguished by its thicker panicles, broader leaves, narrowly ovate, larger spikelets, and more strongly rugose flowering glume.

†† Branches loosely flowered.

‡ Flowering glume strongly transversely undulate-rugose.

§ Leaves pilose.

21. **Chætochloa latifolia** Scribn. U. S. Dept. Agr., Div. Agros. Bul. **11:** 44, pl. 3 (1898). (Fig. 17.)

"A branching annual, 2 to 4 dm. high, with compressed sheaths, rather broad, flat leaves, and bristly panicles 4 to 8 cm. long. Culms compressed, slightly scabrous, and short bearded at the nodes; sheaths striate, scabrous, especially along the keel, papillate-pilose, villous on the overlapping margin; ligule very short and densely ciliate-fringed with stiff hairs; leaf-blades broadly lanceolate, cordate at the base, very acute, 5 to 6 cm. long, 1 to 2 cm. broad, scabrous on both sides and especially along the narrow, cartilaginous margins, strongly pilose above and below. Branches of the panicle very short, slightly crowded; setæ 12 to 18 mm. long, strongly antrorsely scabrous. Spikelets obovate, about 2 mm. long; first glume less than 1 mm. in length, 3-nerved; second glume shorter than the flowering glume, 5-nerved; outer glumes all obtuse, the third one empty; flowering or fruiting glume about 2 mm. long, strongly convex and deeply transversely rugose excepting near the slightly apiculate apex. Palea transversely rugose and similar in texture to the flowering glume.

"Growing under bushes in deep ravines, Durango, Mexico, 879 E. Palmer 1896.

"This species is well marked by its comparatively short and broad leaves, which are cordate at the base, and long, widely spreading bristles."

CHÆTOCHLOA LATIFOLIA BREVISETA var. nov.

A more slender form, with narrower, less pubescent leaves, which do not exceed 1 cm. in width, narrower, few-flowered panicles, and short appressed setæ. Mexico.

SPECIMENS EXAMINED.—*Mexico:* Oaxaca, 347 Conzatti & Gonzalez 1897; no locality, 470 Palmer 1896.

§§ Leaves scabrous.

22. **CHÆTOCHLOA LIEBMANNI** (Fourn.) n. comb. *Setaria liebmanni* Fourn. Mex. Pl. Enum. Gram. 44 (1886).

An erect, glabrous, yellowish-green annual, 3 to 9 dm. high, with broad, flat, soft leaves and loose, lanceolate panicles 1 to 2.5 dm. in length, 2 to 4 cm. in diameter. Culms erect, simple, or sometimes sparingly branched from the base, glabrous, straw colored; nodes glabrous or the lower ones with few appressed hairs; sheaths striate, loose, very glabrous, equaling or slightly exceeding the internodes, the margins cartilaginous, ciliate-fringed with short hairs; ligule short, densely ciliate-fringed with stiff white hairs about 1 mm. long. Leaf-blades lanceolate, somewhat narrowed at the cordate base, long acuminate-pointed, 1 to 3 dm. long, 1.5 to 2 cm. wide, thin, pale, scabrous on both sides and especially on the cartilaginous margins, midvein very prominent below, obscure above. Panicle attenuate at both ends, the axis slender, channeled, scabrous; branches approximate, erect-spreading, scabrous, slender, loosely few-flowered, 1.5 to 3 cm. long, much exceeding the internodes, not remote at the base; setæ one at the base of each spikelet, slender, flexuous, finely antrorsely scabrous, 10 to 15 mm. in length. Spikelets ovate, acute, 2 mm. long, pale, sometimes tinged with purple; first glume cordate, inclosing the base of the spikelet, acute, 3-nerved, one-third as long as the spikelet; second and third glumes broadly ovate, acute, 5 to 7 nerved, the second four-fifths as long as the spikelet, the third slightly exceeding the flowering glume, nerves green, prominent; flowering glume about 2 mm. long, ovate, acute, short-apiculate, strongly convex, striate, very strongly transversely undulate-rugose except near the apex; palea similar in texture and markings to the flowering glume.

Fig. 17.—*Chætochloa latifolia:* *a*, spikelet showing the seta; *b, c*, views of the spikelet; *d*, flowering glume, dorsal view.

In thickets, Mexico. July–October.

SPECIMENS EXAMINED.—*Mexico:* Southwestern Chihuahua, 52 (in part) E. Palmer 1885; E. Palmer 1876; no locality, 233 Palmer 1897; Colima, 142 E. Palmer 1897; Oaxaca, 2788 Nelson 1895; Batopilas, 52, 110*a* Palmer 1885.

Readily distinguished by its yellowish-green color, broad, lanceolate, thin leaves, loose panicles, the branches not remote at the base, and its very strongly rugose flowering glumes.

CHÆTOCHLOA LIEBMANNI PAUCIFLORA (Vasey) n. comb. *Chamæraphis caudata pauciflora* Vasey in Beal Grasses of N. Am. **2**: 158 (1896).

A very slender form, 1 to 4 dm. high, with much smaller, narrow panicles 1 cm. in diameter, 5 to 10 cm. long, the branches not exceeding 1 cm. in length or obsolete, and smaller leaves 5 to 10 cm. long, 3 to 10 mm. broad. Spikelets as in the type.

Mexico and Lower California.

SPECIMENS EXAMINED.—*Mexico:* Southwestern Chihuahua, 52 (in part) Palmer 1885; Guaymas, 191 Palmer 1887; Alamos, 686 Palmer 1890. *Lower California:* San José del Cabo, 12 Brandegee 1890.

In habit very much resembling *Chætochloa grisebachii* (Fourn.), but at once distinguished by its very strongly rugose flowering glumes. *Chamæraphis caudata* (Lam.) Beal, Grasses of N. Am. **2**: 157, to which this form was wrongly referred as a variety, is not true *Panicum caudatum* Lam., but *Chætochloa composita* (H. B. K.), to which the above is not closely related.

‡‡ *Flowering glume smooth or finely transversely wrinkled.*

§ *Spikelets 3 mm. long.*

23. **CHÆTOCHLOA MACROSPERMA** sp. nov. *Setaria composita* of Chapman's Fl. So. U. S. and of Bul. **7**: 85. fig. 67, U. S. Dept. Agr., Div. Agros., not of H. B. K. (Fig. 18.)

FIG. 18.—*Chætochloa macrosperma: a, b,* views of the spikelet; *c,* spikelet showing the setæ.

A very smooth, stout perennial, 6 to 12 dm. high, with broad, flat leaves and branching, bristly panicles 10 to 25 cm. long. Culms cylindrical, robust, geniculate at the base, glabrous; nodes smooth, sheaths compressed, striate, glabrous, the lower exceeding, the upper shorter than, their internodes, margins ciliate; ligule short, densely ciliate-fringed with long white hairs; leaf-blades linear-lanceolate, 1 to 3 dm. long, 10 to 20 mm. wide, somewhat narrowed at the base, and long slender acuminate at the apex, scabrous on both sides or sometimes nearly glabrous; margins cartilaginous, serrate-scabrous, midvein prominent below. Panicle linear-ovate in outline, 2 to 4 cm. in diameter exclusive of the awns;

rachis angular, striate, sparingly villous; branches erect-spreading, the lower ones 1.5 to 3 cm. long, loosely flowered; setæ solitary, 1.5 to 3 cm. long, green, somewhat flexuous, antrorsely scabrous. Spikelets short pedicellate, narrowly ovate, acute, 3 mm. long; first glume cordate, acute, inclosing the base of the spikelet; second glume oval, acute, short apiculate, 5 or rarely 7 nerved, three-fourths the spikelet in length; third glume 5-nerved, equaling the spikelet, slightly inclosing the flowering glume by its infolded edges, subtending a lanceolate, hyaline palea; flowering glume narrowly ovate, acute, striate, finely transversely undulate wrinkled, its palea similar in markings and texture, slightly convex at the base.

Shell islands and keys, sometimes in old fields. Florida, Texas. July–October.

SPECIMENS EXAMINED.—*Florida:* Mouth of the St. Johns River, 3617 Curtiss; Key Largo, 5502 Curtiss 1895; Caloosa River, 41 Garber 1878; Orange Co., 29 Baker 1897; Weston Key, 263 Simpson 1891; Grasmere, 1150 Combs and Rolfs 1898; Cedar Key, 969 Combs 1898; Homosassa, 977 Combs 1898; Crystal, 979½ Combs 1898. *Texas:* Rio Grande, Wright 1848.

FIG. 19.—*Chætochloa villosissima:* a, spikelet showing the seta; b, c, views of the spikelet; d, flowering glume, dorsal view.

24. **CHÆTOCHLOA VILLOSISSIMA** sp. nov. (Fig. 19.)

An erect, somewhat cæspitose more or less densely villous-pubescent perennial, 4 to 10 dm. high, with broad-linear or linear-lanceolate leaves and loose, lanceolate panicles about 2 dm. in length. Culms branching and usually somewhat geniculate at the base, compressed, striate, glabrous; nodes smooth or sparingly bearded with appressed hairs; sheaths loose, striate, compressed, equaling or exceeding the internodes, scabrous above, especially on the keel, nearly smooth below, more or less densely villous-pubescent above, bearded at the apex and ciliate-pubescent on the margins; ligule brown, about 1 mm. long, densely ciliate-fringed with long white hairs; leaf-blades broad-linear, 1.5 to 3 dm. long, 6 to 8 mm. wide, tapering toward the base, long-acuminate at the apex, more or less densely villous-pubescent on both sides, with spreading white hairs, serrulate-scabrous on the cartilaginous margins, midvein prominent on the lower surface for its whole length. Panicle about 2 dm. long, 2 to 3 cm. in diameter below, tapering to the apex, loose; rachis angular striate, scabrous, villous; branches

slender, spreading-erect, the lower 2 to 3 cm. long, few-flowered, much exceeding their internodes; setæ solitary, green, slender, somewhat flexuous, antrorsely scabrous, 1.5 to 2.5 cm. in length. Spikelets lanceolate-ovate, acute, 2.5 to 3 mm. long, pale green; first glume one-third as long as the spikelet, broadly ovate, acute, 3-nerved, somewhat inclosing the base of the spikelet; second glume nearly equaling the flowering glume, ovate, acute, short apiculate, 5 to 7 nerved, the midnerve excurrent, the lateral ones abruptly vanishing in the hyaline margins or anastomosing; third glume equaling the flowering glume, 5-nerved, apiculate, slightly sulcate and inclosing the flowering glume with its infolded margins subtending a very short lanceolate, hyaline palea about one-fifth its own length; flowering glume lanceolate-ovate, acute, abruptly short-apiculate at the incurved tip, rather finely transversely undulate-rugose below, striate and punctate above, the inclosed palea narrow, plane, similar in texture and markings.

Type specimen collected by J. G. Smith at San Diego, Tex., May, 1897. Limpia Canyon, Presidio Co., 115 (in part) Nealley 1892, a smaller undeveloped specimen, with much less pubescent leaves, otherwise as in the type.

A very distinct species, at once distinguished from *C. macrostachya* (H. B. K.) Scribn. and *C. composita* (H. B. K.) Scribn. by its loose, open panicle, larger spikelets, and narrow pubescent leaves, and from *C. macrosperma* by its more open panicle and narrow pubescent leaves.

§ § *Spikelets less than 3 mm. long.*

† *Flowering glume pitted or striate.*

FIG. 20.—*Chætochloa grisebachii: a, b, c,* views of the spikelet; *d,* flowering glume, dorsal view.

25. **Chætochloa grisebachii** (Fourn.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 39 (1897). *Setaria grisebachii* Fourn. Mex. Pl. Enum. Gram. 45 (1886). (Fig. 20.)

A smooth, slender, cæspitose annual, 1.5 to 8 dm. high, with loose, compressed sheaths, short, lanceolate leaves and loose, bristly, panicles 3 to 12 cm. long. Culms branching at the base, very slender, glabrous, generally somewhat geniculate below; nodes bearded with short appressed hairs; sheaths shorter than the internodes, striate, open at the throat, scabrous, sparingly strigose-pubescent, margins ciliate; ligule short, densely ciliate-fringed; leaf-blades lanceolate, slightly narrowed at the cordate base, acuminate, 5 to 10 cm. long, 5 to 10 mm.

wide, scabrous and sparingly short pubescent on both sides, midvein prominent below, becoming obsolete above. Axis of the inflorescence angular, pilose, branches very short, appressed, few-flowered, the lower remote; setæ single or in pairs, somewhat flexuous, widely spreading, purple or sometimes green, 5 to 15 mm. long. Spikelets ovate, acute, 2 mm. long; first glume broadly cordate, inclosing the base of the spikelet, acute, 3-nerved, one-third as long as the spikelet; second glume obtuse, 5 to 7 nerved, nearly equaling the spikelet in length and closely enveloping it; third glume obtuse, 5-nerved, slightly exceeding the flowering glume in length, sulcate, subtending a short hyaline palea; nerves in all the glumes green, prominent; flowering glume nearly 2 mm. long, ovate, acute, nearly smooth, striate, and very finely transversely wrinkled below.

Texas to Arizona. Mexico.

SPECIMENS EXAMINED.—*Texas:* Austin, Hall 1872; no locality, Nealley 1888; Kerrville, Smith 1897; Heller 1894; Limpia Canyon, Presidio Co., 130 Nealley 1892; Smith 1897; Val Verde, Nealley 1890. *New Mexico:* 2096 Wright 1851–52, and 800 Wright 1849, no locality; Mangos, Smith 1897. *Arizona:* Bowie, 4288 Jones 1884; Camp Crittenden, Rothrock 1874; Beaver Creek, 606 McDougal 1891; Clear Creek, 78 Toumey 1891. *Mexico:* City of Mexico, 3040, 3153 Holway 1898; Rio Honda, · Holway 1896; Chihuahua, 381 Pringle 1885; San Luis Potosi, 957 Parry & Palmer 1878; Oaxaca, 4937 Pringle 1894; no locality, 716 Palmer 1896, 1043 Schaffner 1876, 441 Bourgeau 1863–1866; Guanajuato, Dugès 1894.

No. 441 Bourgeau, represented in the Gray Herbarium, is cited by Fournier in the original description as one of the type specimens on which this species is based.

FIG. 21.—*Chætochloa grisebachii ampla:* a, spikelet showing the seta; b, c, views of the spikelet; d, flowering glume, dorsal view.

CHÆTOCHLOA GRISEBACHII AMPLA var. nov. (Fig. 21.)

A very robust form, 5 to 8 dm. high, with thicker culms, longer leaves, and long open panicles; leaves lanceolate, 1 to 2 dm. in length, 10 to 15 mm. wide; panicle loose, 12 to 18 cm. long, 2 to 5 cm. in diameter, the branches spreading, much longer than the internodes, the lower 2 to 3.5 cm. in length.

New Mexico; Mexico.

SPECIMENS EXAMINED.—*New Mexico:* Organ Mountains, Vasey 1881; no locality, 994 Fendler 1847. *Mexico:* no locality, 4670 Pringle 1896; San Bernardino ranch,

Mexican boundary, 2000 Mearns 1893; no locality, 728 Palmer 1896; Oaxaca, 344 Conzatti & Gonzalez 1897.

Readily distinguished from the type by its larger size and elongated, spreading branches of the panicle.

CHÆTOCHLOA GRISEBACHII MEXICANA var. nov. *Setaria mexicana* Schaffner in Herb.

A densely cæspitose form, 6 to 10 cm. high, with interrupted panicles 1 to 3 cm. long and short leaves 2 to 3 cm. in length. Spikelets as in the type.

San Luis Potosi, 1044 Schaffner 1876; Schaffner, Sept., 1877.

‡ *Flowering glume finely transversely wrinkled.*

= *Panicle obtuse at the apex.*

26. **CHÆTOCHLOA POLYSTACHYA** (Scheele) n. comb. *Setaria polystachya* Scheele, Linnæa **22**: 339 (1849). (Fig. 22.)

A stout, erect perennial, 6 to 12 dm. high, with compressed culms, lanceolate leaves, and loose elongated panicles 1 to 2 dm. in length. Culms cylindrical or subcompressed, branching at the base, geniculate, glabrous or slightly scabrous below the nodes and panicle; nodes brown, bearded with short appressed hairs; sheaths striate, glabrous or slightly pubescent above, bearded at the apex, margins ciliate, the lower ones subcompressed, more or less scabrous on the keel; ligule short, ciliate-fringed; leaf-blades 1.5 to 3 dm. long, 1.5 to 2 cm. wide, abruptly narrowed at the base, acuminate, scabrous on both sides and especially so on the cartilaginous margins, the lower ones often more or less strigose-pubescent, midvein prominent below, becoming obsolete above. Panicle pale green, lanceolate, lax, 1.5 to 2.5 dm. long, 1.5 to 3 cm. in diameter; rachis angular, pilose, branches slender, 1.5 to 3 cm. long, erect-spreading, much exceeding their internodes; setæ solitary, 8 to 12 mm. long, green, slender, flexuous, antrorsely scabrous. Spikelets narrowly ovate, acute, 2 mm. long; first glume about one-third as long as the spikelet, slightly inflated, triangular-cordate, acute, 3-nerved; second glume two-thirds as long as the spikelet, acute, 5-nerved, the midnerve excurrent, the lateral ones anastomosing with it; third glume equaling the flowering glume, slightly sulcate, acute, 5-nerved, sub-

FIG. 22.—*Chætochloa polystachya:* *a*, spikelet showing the seta; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

tending a linear-lanceolate, hyaline palea; flowering glume narrowly ovate, acute, short-apiculate, striate, quite strongly transversely undulate-rugose below, striate or pitted at the apex, the inclosed palea narrowly ovate, slightly convex at the base, plane above, striate.

Dry soil, in thickets, etc., Texas. July–October.

SPECIMENS EXAMINED.—*Texas:* Reverchon 1885; Nealley 1888; 164, 564 Lindheimer 1846; 357 Lindheimer 1845; Kerrville, Smith 1897; Gillespie Co., 783 Jermy; Mouth of Pecos River, 34 Havard 1883.

= = *Panicle long-attenuate at the apex.*

27. **Chætochloa caudata** (Lam.) Scribn. Rept. Mo. Bot. Gard. **10**: 52 (1899). *Panicum caudatum* Lam. Illus. **1**: 171 (1791). *Setaria caudata* R. & S. Syst. **2**: 495 (1817). (Fig. 23.)

FIG. 23.—*Chætochloa caudata: a*, branch showing spikelet and setæ; *b*, view of the spikelet; *c*, flowering glume, dorsal view.

A very slender, somewhat cæspitose annual 3 to 6 dm. high, with elongated, interrupted panicles and narrow, linear leaves 1 to 2.5 dm. in length. Culms much branched from the base, geniculate, glabrous, cylindrical, very slender; nodes smooth; sheaths about equaling the internodes, pubescent, ciliate on the margins; ligule short, ciliate. Leaf-blades linear, 1 to 2.5 dm. long, 3 to 5 mm. wide, pubescent on both sides, slightly scabrous on the midvein and margins, long filiform-attenuate at the apex, the upper ones generally equaling or exceeding the culms. Panicles 5 to 15 cm. long, attenuate, few-flowered; rachis slender, flexuous, angular, pilose; branches very short, not exceeding 5 mm., or obsolete; setæ solitary, flexuous, 4 to 10 mm. long, antrorsely scabrous, sometimes somewhat pilose below. Spikelets ovate, acute, short-pedicellate; first glume nearly one-half as long as the spikelet, ovate, acute, 5-nerved; second glume two-thirds the length of the spikelet, broadly ovate, acute, short apiculate, 5 to 7 nerved; third glume equaling the spikelet, 5-nerved; flowering glume ovate, acute, short apiculate, striate, transversely undulate-rugose below, smooth at the apex.

New Jersey, Alabama, and Florida, West Indies, Mexico, South America.

SPECIMENS EXAMINED.—*New Jersey:* Camden, Martindale 1879, on "ballast." *Alabama:* Mobile, Mohr 1891, on "ballast." *Florida:* Key West, Blodgett. *West Indies:* St. Croix, 67 Ricksecker 1895.

The specimen from New Jersey is depauperate, being but slightly over 1 dm. high and densely cæspitose.

28. **Chætochloa setosa** (Sw.) Scribn. U. S. Dept. Agr., Div. Agros. Bul. **4**: 37 (1897). *Panicum setosum* Swartz, Prod. Veg. Ind. Occ. 22 (1788). *Setaria setosa* Beauv. Agrost. 51 (1812). *Chamæraphis setosa* Kuntze Rev. Gen. Pl. **2**: 769 (1891). (Fig. 24.)

An erect branching perennial, 4 to 7 dm. high, with loose, slender, generally long-attenuate panicles 1 to 2.5 dm. in length and linear-lanceolate, pubescent leaves 1 to 2 dm. long. Culms rather slender, glabrous, geniculate at the base, cylindrical or subcompressed, sometimes rooting at the lower nodes; nodes glabrous; sheaths generally equaling or longer than the internodes, loose, striate, nearly smooth at the base, more or less pubescent toward the apex, ciliate on the margins; ligule very short, ciliate; leaf-blades linear-lanceolate, about 1 cm. broad, acuminate, rounded at the base, scabrous on the cartilaginous margins. Panicle lax, attenuate, 1 to 2 cm. in diameter; axis angular, pilose; branches slender, few-flowered, 1 to 2.5 cm. in length, equaling or exceeding the internodes; setæ 1 to 3 at each spikelet, slender, flexuous, scabrous, 10 to 15 mm. long; spikelets 2 mm. long, elliptical-ovate, acute; first glume about one-half the length of the spikelet, acute or acuminate, 3-nerved; second glume nearly equaling the spikelet, ovate, acute, abruptly apiculate, 5-nerved; third glume equaling the fourth, 5-nerved, subtending a hyaline palea which nearly equals the flowering glume in length; flowering glume about 2 mm. long, narrowly ovate, acute or acuminate, finely transversely rugose, especially below. Palea similar in markings and texture, equaling the glume in length.

FIG. 24.—*Chætochloa setosa:* *a*, spikelet showing seta; *b*, *c*, views of the spikelet; *d*, flowering glume, dorsal view.

New Jersey, New Mexico, West Indies, Mexico, South America.

SPECIMENS EXAMINED.—*New Jersey:* Camden, Parker 1879, on "ballast;" also collected by Martindale, no date. *New Mexico:* Organ Mountains, 438 Wooton 1897. *West Indies:* Kingston, Jamaica; Alexander 1853; March 1886, no locality; spikelets from specimen in Kew Herbarium, cited by Grisebach Fl. Brit. W. Ind. 555; same

also in the Gray Herbarium, Cambridge; St. Croix, Eggers 1876; St. Thomas, Eggers 1876 and 1890; Gordon Town, 829 Hart 1886. *Mexico:* Monterey, Nuevo Leon, 1968 Pringle 1888.

The specimen from New Mexico, 438 Wooton 1897, is not typical and differs from the other specimens cited in having the sheaths somewhat compressed, slightly keeled, the setæ longer, and the panicle obtuse at the apex, not long-attenuate.

In H. B. K. Nov. Gen. & Sp. Pl. 1: 110 (1815) this species is cited as a synonym of *Setaria macrostachya*, but from a careful comparison of the original descriptions, authentic specimens, and the literature on the subject they appear to be very distinct. Nees[1] says that Swartz's specimens, which he has seen in the Schreber Herbarium, differ from *S. macrostachya* H. B. K. in having the second glume 5-nerved, narrower, pubescent leaves, and lax, elongated, and attenuated panicles. Trinius[2] says that the details of *Panicum setosum*[3] do not belong to this species, but to *P. onurum*, which has been confounded with it; hence the confusion regarding this species.

NORTH AMERICAN GRASSES WHICH HAVE BEEN WRONGLY REFERRED TO THE GENUS CHÆTOCHLOA (SETARIA).

Setaria auriculata Fourn. Mex. Pl. Enum. Gram. 43 (1886) =*Setariopsis auriculata* (Fourn.) Scribn.

Setaria cirrhosa Fourn. Mex. Pl. Enum. Gram. 43 (1886)=**Panicum cirrhosum** (Fourn.) n. comb.

Setaria effusa (Fourn.) Mex. Pl. Enum. Gram. 42 (1886)=**Panicum mexicanum** nom. nov.

Setaria jurgensenii Fourn. Mex. Pl. Enum. Gram. 42 (1886)=**Panicum jurgensenii** (Fourn.) n. comb.

Setaria latiglumis Vasey Bul. Torr. Bot. Club. **13**: 229 (1886)=*Setariopsis latiglumis* (Vasey) Scribn.

Setaria paniculifera (Steud.) Fourn. Mex. Pl. Enum. Gram. 42 (1886)=*Panicum paniculiferum* Steud. Syn. Gram. 54. 1855.

Setaria pauciseta Vasey Bul. Torr. Bot. Club **13**: 230 (1886)=*Setariopsis auriculata* (Fourn.) Scribn.

Setaria schiedeana (Schlecht.) Fourn. Mex. Pl. Enum. Gram. 43 (1886)=*Ixophorus schiedeana* Schlecht. Linnæa **31**: 421 (1861).

Setaria sulcata Raddi Agrost. Bras. 50=*Panicum sulcatum* Aubl.

Setaria uniseta (Presl) Fourn. Mex. Pl. Enum. Gram. 43 (1886)=*Ixophorus unisetus* Schlecht. Linnæa **31**: 421 (1861).

Chamæraphis uniseta of Beal's Grasses of N. Am. **2**: 158 (1896) is *Chætochloa grisebachii.*

DOUBTFUL AND UNKNOWN SPECIES CREDITED TO NORTH AMERICA.

Setaria affinis Schrad. in R. & S. Mant. **2**: 276 (1824), Described by Muhlenberg in Desc. Gram. 101 (1817) without name=(?) *Chætochloa corrugata parviflora.* Southern States.

Setaria ambigua Schrad. Linnæa **12**: 430 (1838). Type material collected in Texas=(?) *Chætochloa imberbis geniculata.*

Setaria biconvexa Grisebach Fl. Brit. W. Ind. 555 (1864). Scarcely distinct from *C. onurus.* Spikelets from Grisebach's type specimen sent from Kew Herbarium agree almost perfectly with those of *C. onurus.* *S. biconvexa* is described as having the second glume 7-nerved as a distinguishing character from the 9 to 11 nerved second glume of *S. onurus*, but the spikelets from Grisebach's type have the second glume 9-nerved!

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[1] Agrost. Bras. **2**: 246. [2] Mem. Acad. Sci. St. Petersb., ser. 6, **3**: 138, 139.
[3] Trin. Icon. t. 95.

Setaria californica Kellogg Proc. Cal. Acad. Sci. 1: 26 (1873). Collected at Shasta, on the Sacramento River, and described as being about 12 feet high, with erect, cylindrical spikes a foot long, with densely villous rachis, and smooth flowering glume. From the description and the fact that this prominent form has not been collected since, there can be little doubt that it was a form of *Chætochloa italica*, escaped from cultivation but not persisting.

Setaria falcifolia Fourn. Mex. Pl. Enum. Gram. 44 (1886). Mexico.

Setaria flava Kunth, Rev. Gram. 1: 46 (1829). Described from South American material and credited by Fournier to Mexico. No specimens have been seen which agree with Kunth's description, and the specimens cited by Fournier (231 Bourgeau and 30 Liebmann), which were examined, are referable to *C. purpurascens.*

Setaria lævis Fourn. Mex. Pl. Enum. Gram. 45 (1886). Mexico.

Setaria pseudoverticillata Fourn. Mex. Pl. Enum., 45 (1886). Mexico.

Setaria rariflora Presl Rel. Hænk. 1: 313 (1830). Mexico.

Setaria semirugosa Kunth Enum. Pl. 1: 152 (1833). Described from South American material and credited by Fournier to Mexico. No specimens seen from North America.

Setaria stipæculmis C. Mueller Bot. Zeit. 19: 323 (1861). This is certainly not a *Setaria*, as is very evident from the original description. Texas.

Setaria vulpiseta R. & S. Syst. 2: 495 (1817). Credited by Grisebach to the West Indies. No specimens seen. Fournier (Mex. Pl. Enum. Gram. 45) says that the specimens referred by Grisebach to *S. vulpiseta* are *S. macrostachya* H. B. K.

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BULLETIN No. 23. Agros. 65.

U. S. DEPARTMENT OF AGRICULTURE,

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

STUDIES

ON

AMERICAN GRASSES.

A REVISION OF THE NORTH AMERICAN SPECIES OF BROMUS OCCURRING NORTH OF MEXICO.

BY

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF AGROSTOLOGY,
Washington, D. C., April 9, 1900.

SIR: I have the honor to transmit herewith the manuscript of a paper entitled A Revision of the North American Species of Bromus Occurring North of Mexico, prepared under my direction by Mr. Cornelius L. Shear, assistant agrostologist, and recommend the same for publication as Bulletin No. 23 of this division, under the general title of "Studies on American Grasses."

The abundance of good material collected during the past few years in the Rocky Mountains and the Northwest has shown the necessity of a revision of the genus *Bromus*. Until very recently good specimens from these regions have been few, and their identification has rested in many cases on tradition and misconceptions of the species. As an illustration of this, the case of *B. breviaristatus* may be cited. The identification of this species was based by Thurber and Gray on specimens distributed by Hooker under that name. These specimens when compared with the original illustration of the species and the actual type prove to be the old and well-known *B. unioloides*. The examination of portions of the types of Hooker, Link, and Nuttall has made it possible to treat more satisfactorily the various forms from the same region that have passed for *B. ciliatus* and its varieties. Thus *B. vulgaris*, which is one of the best-defined species of the Northwest, has heretofore passed as *B. ciliatus* or *B. purgans*, or a variety of one or the other. The group presenting the most difficulties in the way of satisfactory segregation is that to which *B. carinatus* and *B. marginatus* belong. Here the forms and variations are so many and perplexing that the present disposition of them is necessarily more or less tentative. In the thorough study of the group Fournier's Mexican forms must be considered, and these are so confused and poorly segregated that only a comparison of his types can make a satisfactory disposition of them possible.

The present paper contains descriptions of 36 species and 28 varieties, 45 of which are natives and 19 introduced. The enumeration includes a new subgenus, 3 new species, and 15 new varieties.

Respectfully,

F. LAMSON-SCRIBNER,
Agrostologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

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ILLUSTRATIONS.

A REVISION OF THE NORTH AMERICAN SPECIES OF BROMUS OCCURRING NORTH OF MEXICO.

INTRODUCTION.

It does not appear that any attempt has heretofore been made to revise the species of *Bromus* of any very extensive region. In the present paper the species of North America north of Mexico are treated. Those of Mexico are so poorly known that no satisfactory disposition can be made of them until more extensive collections have been examined and the types of Fournier's species and varieties studied. A careful study of the types of the species of Humboldt, Bonpland and Kunth and Presl from the region of the Andes is also necessary in order to correctly understand our southwestern and Mexican species of the sub genus *Ceratochloa*.

The number of known species of *Bromus*, according to Bentham in his "Notes on Gramineæ" in 1881, was about 40. This is the most recent estimate, but according to Index Kewensis and the study of recent literature a total of 150 species would be a conservative estimate of the number at present known. The number of species and varieties described in this paper is 64. Of these 45 are indigenous, and the remaining 19 adventive or introduced. Three are regarded as new species, and fifteen as new varieties. A few species credited to North America still remain doubtful or unknown to us. These have been added at the end of the paper with their original descriptions.

We desire here to acknowledge our great indebtedness and express our thanks to the following botanists who have rendered valuable assistance in the preparation of this paper, either by the loan or contribution of material or by the copying of original descriptions or plates: Drs. B. L. Robinson, Wm. Trelease, N. L. Britton, J. K. Small, P. A. Rydberg, and I. Urban, also Sir W. T. Thiselton-Dyer, Miss Alice Eastwood, and Prof. C. V. Piper.

CLASSIFICATION.

The first step necessary in revising a genus is to decide what shall be considered its type. Then follows the question of its limitations. In this case, as in so many others, Linnæus, who is cited as the author

of the name, was not the first to apply it to a genus. In Gen. Pl. ed. 4, 26. 1752, he cites Monti (Cat. Stirp. Agri. Bonon. Prod. 32. 1719) as the author of the genus. For figures of species which he evidently regarded as typical he cites Scheuchzer's Agrost. Helv. Prod. *pl. 5. figs. 2, 10, 11, 12.* 1708. Referring to Scheuchzer's figures, No. 2 appears to be a species of *Deschampsia*, which Linnæus one year later, Sp. Pl. **1**: 65. 1753, refers to *Aira cæspitosa*, but does not mention it under *Bromus*, so it is rather evident that the reference to it under that genus was an error. The next figure cited, 10, is undoubtedly a *Bromus*, and is referred by Linnæus to B. *arvensis* l. c. by citation of description but not of figure. By some error on the part of Scheuchzer, his figure 10 is referred to on different pages as representing two different things. Figure 11 Linnæus refers in the same place to *B. squarrosus* and figure 12 in the first edition of "Species Plantarum" is referred to *B. tectorum*, but in the second edition it is referred to *B. mollis* (*hordeaceus*), which it evidently is. Thus it is sufficiently clear what section at least of the genus as here treated, Linnæus had in mind as the basis of his genus. But according to the present rules of American nomenclature, 1753 is taken as the starting point for genera as well as species. Following this, some arbitrary means must be resorted to in deciding what shall be recognized as the types of Linnæus's genera, since there are no generic descriptions in the "Species Plantarum." The most simple and logical plan we believe would be to adopt the first species mentioned as the type, which, applied to the case in hand, would make the type of our genus *B. secalinus*, thus bringing about in this case practically the same results as by the first method, as the species first referred to by Linnæus, *B. arvensis*, *B. squarrosus*, and *B. mollis* are all intimately related to *B. secalinus*.

This genus in the sense in which it is here treated has been the subject of many divisions and subdivisions; at least ten different genera based upon various species have been proposed. The present tendency among many botanists is toward the narrower limitation of genera, but it has seemed best in this paper to maintain the genus in its broadest sense. Of the various genera proposed *Ceratochloa* is perhaps, on the whole, the best defined, while the subgenus *Neobromus* is rather anomalous, and may be eventually found worthy of generic rank. This subgenus, which includes so far as at present known only *Bromus trinii* and its several varieties, shows very close relationship with *Avena* and *Trisetum*, to each of which genera forms of it have been referred. In its various forms it appears to have reached its greatest development in the Andes of South America and is restricted in its distribution to the western portion of the western continent.

The following list shows in order of their publication the various genera proposed for species here included in the genus Bromus:

Lasiopoa Ehrh. Beitr. **4**: 147. 1789.
Ceratochloa Beauv. Agrost. 75. *t. 15. f. 7.* 1812.
Schedonorus Beauv. Agrost. 99. 1812. This, apparently by mistake, stands *Schenodorus* in the index, 177, of the work cited. Beauvois included under *Schedonorus* mostly species of *Festuca*. He cites no type for the genus, so we have accepted the first species mentioned, *Festuca elatior* L., as the type. Only one or two species of true *Bromus* were included by him, one of which was *B. inermis*.
Zerna Panz. Denkschr. Acad. München. 296. 1813.
Michelaria Dum. Obs. Gram. Belg. 77. *t. 16.* 1823.
Libertia Lej. Nov. Act. Nat. Cur. **12**: 755. *t. 65.* 1825.
Serrafalcus Parl. Pl. Nov. 75. 1842.
Anisantha C. Koch, Linnæa **21**: 394. 1848.
Triniusia Steud. Syn. Pl. Gram. 328. 1854.
Bromopsis Fourr. Ann. Soc. Linn. Lyon n. ser. **17**: 187. 1869.

Zerna was originally made to include the species of the subgenus *Stenobromus* as well as those related to *B. asper*.

Michelaria and *Libertia* are synonyms, both being founded on *B. arduennensis* Dum., a Belgian species resembling *B. squarrosus* somewhat but having the angle on the margin of the flowering glume extended in the form of a tooth.

Serrafalcus was applied to the group containing *B. secalinus* and closely allied species, which Linnæus regarded as typical of his genus *Bromus*.

Anisantha was founded on *B. pontica* Koch, which is considered to be *B. tectorum* L.

Bromopsis was applied to *B. asper* and *B. erectus*, and is synonymous with *Zerna*, as here emended.

Triniusia was founded on *B. danthoniæ* Trin., and may be a valid genus. It is not represented in our territory.

The greatest difficulties in the treatment of the subject are connected with the segregation and delimitation of species and varieties. In order to arrive at a stable basis for the foundation and separation of species, it is quite necessary that one should know exactly what the type of each species is. Various authors differ as to the limitation of species, and it can scarcely be expected that there will be a unanimous opinion as to these limitations, but if the typical form of a species be recognized and taken as the fixed point that must remain undisturbed, however many or few forms may be grouped around it, much confusion would be avoided. As a basis of the present revision we have made a careful study of the original descriptions of the species and also have had an opportunity of examining the types or portions of the types of the most of our endemic forms. This has shown the necessity of a number of changes in the nomenclature of our species, the determination of some of them having heretofore rested upon traditions and interpretations, which investigations of the types prove to be incorrect. Besides the study of original descriptions and types, we have had an opportunity to study most of the forms in the field during the past five seasons, and have also been able to examine the collections of a number of the larger herbaria of this country. The species, as in most of our genera of wide distribution, are very varia-

ble, and their separation becomes to a great extent a matter of personal judgment, and hence arbitrary. Nearly all of the so-called specific characters are variable. The most common variations are in the amount and distribution of the pubescence, the width of the glumes and leaves, and the length of the awns. In most instances the amount and distribution of the pubescence of the flowering glume, taken in connection with other corelated characters of the plant, have been found to furnish a fair basis for segregation, especially where these characters are found to coincide with geographic distribution and environment. It has been found, however, that a character which seems fairly stable in one species may be much more variable in another, so that no character in general can be said to have specific value, but the value of each character must be determined by careful study and observation of the plants throughout a considerable territory. Species founded on single characters are always artificial, rather than natural. There are scarcely any of our species that do not show intermediate forms. In some instances, of course, these are much more numerous than in others. The subgenus *Ceratochloa* presents the most numerous and perplexing forms. These seem to be largely due to the wide distribution and varied climatic and physiographic conditions under which they are found.

The advisability of the adoption of so many varieties may perhaps be questioned by some as tending to make nomenclature too cumbersome. As the chief value of the work, however, seems to us to lie in bringing out as clearly as possible the degrees of relationship and relative importance of the various groups as well as their connection with physical environment and geographical distribution, this course has been followed as best serving the end in view.

An attempt is here made to illustrate diagrammatically what appears to us the relationships of the subgenera and species.

The first group, *Bromus* proper, is made up entirely of forms which have been introduced from Europe.

brizæformis —— —— —— —— *squarrosus*

ARVENSIS —— —— —— *patulus*

secalinus —— —— *racemosus*

scoparius —— —— —— *hordeaceus*

The second group, subgenus *Neobromus*, represented by one species and its varieties, shows no close relation with our other species, but seems to approach nearest *B. scoparius* and *B. tectorum*.

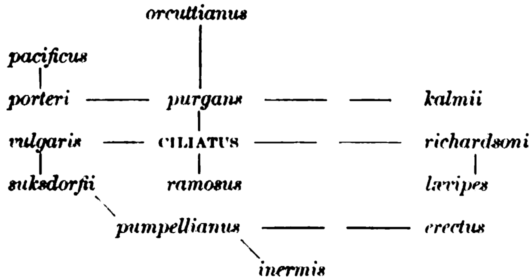
The subgenus *Stenobromus* also consists entirely of introduced species.

maximus

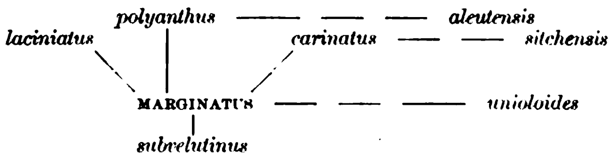
madritensis —— —— *rubens*

sterilis —— —— —— *tectorum*

The subgenus *Zerna* as here emended contains the largest number of our endemic species. They are widely distributed throughout our region and are quite variable.



The subgenus *Ceratochloa* is apparently peculiar to the western portions of North and South America, ranging from Alaska to Cape Horn.



It is impossible to represent by diagram, except in a very general way, the various relationships of a species. If the species diverged along one or two lines, it would not be so difficult; on the contrary, each shows more or less variation in several directions, so that the typical form might more properly be regarded as a center from which lines diverge in various directions.

The results of this study, which seem to us of most general scientific importance, are those which give us a clew to the derivations and relations of the various species. It will be noticed that comparatively few synonyms are given under the species. By listing all the synonyms given by various authors a very long but unreliable list might have been made; it has seemed to us preferable, however, to restrict the synonymy to those names whose identity we have been able to verify, either by the examination of the types or of authentic material. In rare instances we have been obliged to accept the authority of those who have had excellent opportunity for comparison and study of the species referred to.

DISTRIBUTION.

The genus *Bromus* is most widely distributed in the temperate and mountain regions of the world. The genus seems to have reached with us its greatest development in the Rocky Mountains. In the tropics the species are almost entirely restricted to the higher mountains. Some of the species are more or less distributed in arctic regions also. The highest altitude reached by any species is about 4,000 meters, in the Rocky Mountains of Colorado. The species is *Bromus*

porteri. In the Rocky Mountain region and on the west coast we have abundant representatives of the *Ceratochloa* group, which is found from western Alaska to Cape Horn, but is not represented, so far as we know, on the Eastern Hemisphere, except by introduced forms of *B. unioloides*. Our species in the Northwest show an intimate connection with some of those in eastern Siberia. This is especially marked in the case of *Bromus pumpellianus*, whose Siberian equivalent is *B. inermis*. Unfortunately we have not sufficient material of Siberian species at hand to carry farther the comparison. In the South many forms of the subgenus *Ceratochloa* are connected by way of the mountains through Mexico and Central America with those of the Andes, so that it will be necessary, in order to make a comprehensive and satisfactory disposition of this group, to study carefully representatives from the Andes region, as well as from farther south.

ECONOMIC IMPORTANCE.

A number of species are of economic importance, either on account of their value as forage or because of their weedy propensities. Ranking first as a forage plant comes *Bromus inermis* (smooth or Hungarian brome grass). This species, introduced from Europe, has been extensively tried in the semiarid portions of the West and found to be well adapted to the conditions prevailing there. It is excellent for either hay or pasture.

Bromus unioloides, usually sold under the name of Schrader's brome grass, is another species which has been cultivated considerably in the southern parts of the United States.

Bromus secalinus, cheat or chess, though usually regarded as a weed in grain fields in the East, is cultivated for hay quite extensively in western Oregon and Washington.

Bromus pumpellianus, a native of the northern Rocky Mountain region, has been tried in cultivation and found very promising. It is very closely related to *Bromus inermis* and adapted to similar conditions of soil and climate.

Bromus marginatus latior has also been used for hay to some extent in Oregon and appears worthy of further attention.

Nearly all of the introduced species show decided weedy propensities and are quite troublesome, especially on the west coast. *Bromus hordeaceus* and its variety *glabrescens* have taken possession of vast areas (see *B. hordeaceus*) of deteriorated range land in California, Oregon, and Washington. *Bromus sterilis*, *B. maximus*, and *B. madritensis* are also common weeds in grain fields and waste places in the same States.

BROMUS L. Gen. Pl. 15. 1737.

Spikelets few to many-flowered, slightly or more rarely strongly flattened laterally, in panicles, or rarely racemed; rachilla articulated above the empty glumes and between the florets; florets hermaphrodite or the uppermost imperfect; empty glumes at the base of the spikelet 2, unequal, acute, or the second short-awned, 1 to 7 nerved, shorter than the flowering glumes; flowering glumes keeled or more often rounded on the back, 5 to 9 nerved, usually 2-toothed at the apex, awned from the back just below or from between the teeth, sometimes awnless; awn straight or divergent, sometimes twisted. Palea usually a little shorter than the glume, 2-keeled. Stamens usually 3. Stigmas plumose, sessile, springing from below the hairy cushion-like apex of the ovary. Grain furrowed and grown to the palea. Annual or perennial grasses with flat leaves and rather large, erect or pendulous spikelets.

The genus is very closely related to *Festuca*, from which it differs in general in its larger spikelets, more or less dentate apex to the flowering glume and in the character of the ovary, and the habit of growth which is very rarely cæspitose. Some species show close relationship with *Avena*, *Trisetum*, and *Danthonia*, while others are very close to *Melica*.

ANALYTICAL KEY TO THE SPECIES AND VARIETIES.

1. Flowering glume with pubescence about equally distributed over the whole dorsal surface 2
1. Flowering glume with pubescence conspicuously unevenly distributed over the dorsal surface, longest and densest on the margins or base or both 25
1. Flowering glume smooth or scabrous 35
2. Spikelets 5–9 mm. broad, laterally flattened before flowering 3
2. Spikelets usually less than 5 mm. broad before flowering and terete or subterete. 6
3. Awn not exceeding 7 mm. long, usually shorter 4
3. Awn usually more than 7 mm. long 24
4. Leaves linear, somewhat involute and pilose-pubescent .. **30 B. subvelutinus.**
4. Leaves linear-lanceolate, flat 5
5. Panicle narrow, lower branches not exceeding 10 cm. long. **31 B. marginatus.**
5. Panicle rather broad, some of the lower branches exceeding 10 cm. long .... **31 B. marginatus latior.**
6. Panicle rather lax and drooping in flower 7
6. Panicle as a whole not conspicuously secund or drooping in flower 17
7. Perennials, native 8
7. Annual, introduced .... **14 B. tectorum.**
8. Species restricted to the Rocky Mountains and westward 9
8. Species east of the Rocky Mountains 14
9. Lower empty glume 1-nerved, lanceolate, acute 10
9. Lower empty glume 3-nerved, broadly lanceolate, subacute.... **19 B. porteri.**
10. Lower empty glume 5 mm. or more long 11
10. Lower empty glume usually less than 5 mm. long... **19β B. porteri havardii.**
11. Sheaths densely pilose-pubescent .... **19α B. porteri lanatipes.**
11. Sheaths not densely pilose-pubescent 12
12. Empty glumes more or less pubescent 13
12. Empty glumes smooth .... **19γ B. porteri frondosus.**
13. Culm tall, stout; panicle heavy .... **20 B. pacificus.**
13. Culm rather slender; panicle not heavy .... **23 B. vulgaris.**
14. Lower empty glume 1-nerved, acute 15
14. Lower empty glume more or less distinctly 3-nerved .... **18 B. kalmii.**

15. Sheaths without a ring of pilose pubescence at the base of the blade........ 16
15. Sheaths with a ring of pilose pubescence at the base of the blade...............
.... **20α B. purgans latiglumis.**
16. Sheaths densely soft pilose-pubescent .... **21γ B. purgans incanus.**
16. Sheaths sparsely pilose-pubescent or nearly smooth .... **21 B. purgans.**
17. Flowering glumes acute or subacute with not more than 5 distinct nerves ... 18
17. Flowering glumes broad, obtuse or sub-obtuse, 7-nerved.................... 22
18. Awn of flowering glume straight at maturity 19
18. Awn more or less twisted and divaricate at maturity....................... 21
19. Branches of the panicle rather rigid and spreading in fruit . **22 B. orcuttianus.**
19. Branches of the panicle not rigid nor broadly spreading...................... 20
20. Leaves of the innovations narrow and involute................. **26 B. erectus.**
20. Leaves not involute and panicle not strictly erect .. **21β B. purgans texensis.**
21. Panicle more than 2 dm. long.................... **9α B. trinii pallidiflorus.**
21. Panicle smaller; mostly less than 2 dm. long..................... **9 B. trinii.**
22. Awn twisted and divaricate at maturity 23
22. Awn not conspicuously twisted or divaricate............... **3 B. hordeaceus.**
23. Panicle dense; usually less than 12 cm. long.. **3α B. hordeaceus intermedius.**
23. Panicle looser; more than 15 cm. long .... **9 β B. trinii excelsus.**
24. Leaves of the innovations numerous, narrow ..... **35δ B. carinatus linearis.**
24. Leaves of the innovations few; more than 2 mm. broad ..... **35 B. carinatus.**
25. Panicle rather broad, loose and drooping.................................. 26
25. Panicle rather narrow and erect or not conspicuously drooping 31
26. Awn more than 6 mm. long 27
26. Awn less than 6 mm. long.. 29
27. An introduced species with broad, loose panicle.............. **15 B. ramosus.**
27. Native species, with rather narrow panicles............................... 28
28. Leaves and sheaths glabrous; leaves usually more than 7 mm. broad ....
....**23α B. vulgaris eximius.**
28. Leaves and sheaths more or less pilose-pubescent; leaves less than 7 mm. broad
.... **23β B. vulgaris robustus.**
29. Flowering glume pubescent above the middle on the margin and across the lower half of the back... 30
29. Flowering glume ciliate-pubescent on the margin, the pubescence extending very little above the middle.. 31
30. Ligule 2 mm. or more long; plants with creeping rootstocks ... **24 B. lævipes.**
30. Ligule less than 2 mm. long; plants without creeping rootstocks ....
.... **17 B. richardsoni.**
31. Native of the Rocky Mountains westward and northward.........................
.... **17α B. richardsoni pallidus.**
31. Native of the Northeastern States and northward.............. **16 B. ciliatus.**
32. Panicle broad, branches widely spreading in flower, introduced.. **27 B. inermis.**
32. Panicle rather narrow with erect or ascending branches 33
33. Panicle narrow and rather rigidly erect; flowering glume short-pubescent or puberulent on the margin .... **25 B. suksdorfii.**
33. Panicle not rigidly erect... 34
34. Awn wanting or not exceeding 2 mm.; flowering glume with margin short-pubescent .... **28β B. pumpellianus melicoides.**
34. Awn usually exceeding 2 mm.. 35
35. Margin of the flowering glume very densely ciliate-pubescent nearly to the apex
.... **28α B. pumpellianus tweedyi.**
35. Margin of the flowering glume with shorter pubescence not reaching to the apex .... **28 B. pumpellianus.**
36. Spikelets large, somewhat laterally compressed before flowering 37

36. Spikelets not flattened laterally before flowering........................ 49
37. Awn exceeding 7 mm. long.. 38
37. Awn less than 7 mm. long.. 41
38. Flowering glume very broadly lanceolate, subacute, distinctly 7-nerved ....
.... **33 B. aleutensis.**
38. Flowering glume lanceolate, acute, usually 5-nerved........................ 39
39. Flowering glume 18–20 mm. long; awn 11–15 mm. long ....
.... **35β B. carinatus hookerianus.**
39. Flowering glume 14–16 mm. long; awn 7–10 mm. long 40
40. Panicle very broad, longest branches 15 mm. or more long, lax and drooping; leaves broad.. **34 B. sitchensis.**
40. Panicle narrower, longest branches less than 15 mm. long; leaves rather narrow..
.... **35α B. carinatus californicus.**
41. Panicle erect or suberect, lower branches rarely more than 10 cm. long...... 42
41. Panicle with upper part more or less drooping; lower branches rather weak, the longest usually more than 10 cm. long 46
42. Awn wanting or less than 4 mm. long.. 43
42. Awn 4 mm. or more long 44
43. Spikelets about 1 cm. broad, Briza-like .... **7 B. brizæformis.**
43. Spikelets narrower, not resembling those of Briza............................
.... **29α B. unioloides hænkeanus.**
44. Flowering glumes scabrous-puberulent 45
44. Flowering glume smooth or merely scabrous................ **32 B. polyanthus.**
45. A native of the southwest, Arizona, and southward. **35ε B. carinatus arizonicus.**
45. A native of the northwest, Wyoming, Oregon, and northward..................
.... **31β B. marginatus seminudus.**
46. Palea more than three-fourths the length of its glume...................... 47
46. Palea three-fourths the length of its glume or less .... **29 B. unioloides.**
47. Panicle rather lax and open, not dense 48
47. Panicle large, suberect, and rather dense........... **35γ B. carinatus densus.**
48. Plants with broad leaves, usually more than 7 dm. high ....
.... **32α B. polyanthus paniculatus.**
48. Plants usually less than 7 dm. high with rather short, narrow leaves ....
.... **36 B. laciniatus.**
49. Awn distinctly twisted and divaricate.. 50
49. Awn not distinctly twisted and divaricate 52
50. Panicle short and dense.. **8 B. scoparius.**
50. Panicle rather large and open 51
51. Spikelets usually more than 5 mm. broad in flower........... **6 B. squarrosus.**
51. Spikelets 5 mm. or less broad in flower .... **5 B. patulus.**
52. Panicle short and contracted 53
52. Panicle rather broad and open.. 56
53. Flowering glumes elliptic..................... **3β B. hordeaceus glabrescens.**
53. Flowering glumes narrow-lanceolate 54
54. Awn 35 to 40 mm. or more long .... **11 B. maximus.**
54. Awn less than 30 mm. long.. 55
55. Panicle forming a dense head rarely exceeding 5 cm. long ...... **12 B. rubens.**
55. Panicle less dense and usually longer .... **10 B. madritensis.**
56. Flowering glumes elliptic or ovoid-lanceolate 57
56. Flowering glumes oblong lanceolate to narrow-lanceolate..................... 60
57. Margins of flowering glumes not strongly involute in fruit 58
57. Margins of flowering glumes strongly involute in fruit .... **1 B. secalinus.**
58. Panicle rather small and subracemose .... **2 B. racemosus.**
58. Panicle rather large and broad.. 59

59. Spikelets less than 6 mm. broad in flower .... **4 B. arvensis.**
59. Spikelets more than 6 mm. broad in flower ... **2α B. racemosus commutatus.**
60. Awn more than 15 mm. long 61
60. Awn much less than 15 mm. long, sometimes wanting 62
61. Awn usually more than 35 mm. long .... **11α B. maximus gussoni.**
61. Awn usually less than 30 mm. long .... **13 B. sterilis.**
62. Awn usually less than 3 mm. long .... **27 B. inermis.**
62. Awn usually more than 3 mm. long .... **16α B. ciliatus læviglumis.**

I. BROMUS PROPER.

A. *Annuals or sometimes biennials with empty glumes rather broad and the flowering glume broadly elliptic to oblong-elliptic. Species all introduced.*

1. BROMUS SECALINUS L. Sp. Pl. 1: 76. 1753. *Serrafalcus secalinus* Bab. Man. Brit. Bot. 374. 1843. (Fig. 1.)

An erect annual. Culm 3–7 dm. high, smooth throughout or somewhat pubescent at the nodes. *Sheaths typically smooth*, sometimes the lowest sparsely pilose-pubescent; ligule about 1 mm. long, truncate, somewhat irregularly dentate; blades mostly 1–2 dm. long, linear-lanceolate, with coarse, sparse hairs above, smooth beneath. Panicle about 8–18 cm. long, at first erect, the upper part drooping in fruit, pyramidal in outline; *lower branches 3–5*, unequal. *Spikelets ovoid-lanceolate, becoming somewhat laterally compressed and turgid in fruit*, 10–18 mm. long,[1] 6–8 mm. broad in fruit; empty glumes smooth, obtuse, the lower 4–6 mm. long, 3–5-nerved, the upper broader, *6–7 mm. long*, 7-nerved; flowering glumes 7-nerved, 6–8 mm. long, elliptic, obtuse, smooth or scabrous, *having the margin strongly involute in fruit*, shortly bidentate at the apex *with the undulate awn mostly 3–5 mm. long*, inserted about 1 mm. below the apex; *palea equal to or only very slightly shorter than its glume.*

FIG. 1.—*Bromus secalinus*: *a*, spikelet.

General distribution: This species, introduced from Europe, is very generally distributed throughout the United States.

SPECIMENS EXAMINED.—*Maine:* N. Berwick (J. C. Parlin 566). *Ontario:* Galt (W. Herriott). *Connecticut:* Fairfield (E. H. Eames). *New York:* Oxford (F. V.

[1] All measurements of spikelets and glumes are exclusive of the awns.

Coville). *Pennsylvania:* Philadelphia (I. C. Martindale 15). *Delaware:* Centreville (A. Commons 135, 136). *Maryland:* Rocky Springs (J. E. Miller). *District of Columbia:* Washington (G. Vasey); (T. H. Kearney, jr.). *Florida:* Chipley (R. Combs 684). *Alabama:* Tuskegee (G. W. Carver). *Tennessee:* Hiwassee Gorge (T. H. Kearney, jr. 311). *Ohio:* Pittsfield (A. E. Ricksecker); Youngstown (R. H. Ingraham). *Indiana:* Millers (L. M. Umbach). *Michigan:* Thunder Bay Island (C. F. Wheeler). *Wisconsin:* Near Webster (L. S. Cheney 3430). *Minnesota:* Wilmar (W. D. Frost); Cannon Falls (J. H. Sandberg 327). *Iowa:* Minerva (C. R. Ball 9); Ames (C. R. Ball 35, 150); Newmarket (B. Shimek 12). *Missouri:* St. Louis (Drummond 647). *Texas:* Ennis (J. G. Smith); El Paso (E. A. Mearns 1479, 1482). *New Mexico:* Cliff (J. K. Metcalfe). *Arizona:* Near Flagstaff (D. T. McDougal 303). *Utah:* Provost (M. E. Jones 5499); Ogden (T. A. Williams 2482); Salt Lake City (M. E. Jones 1009). *Colorado:* Estes Park (J. Ball); near Silverton (C. L. Shear 1239). *Wyoming:* Near Beulah (David Griffiths 405). *Montana:* Bozeman (P. A. Rydberg 2214; C. L. Shear 453); Garrison (C. L. Shear 368). *Idaho:* Farmington Landing (Sandberg, Heller & McDougal 531); Forest (H. E. Brown 26). *Washington:* (Leiberg & Sandberg 399); Waitsburg (R. M. Horner 564); Walla Walla (C. L. Shear 1557, 1597). *Oregon:* McMinnville (C. L. Shear 1618); Corvallis (M. Craig 9344). *California:* Dixie Valley (J. B. Davy).

This plant is very closely related to several other species, especially *B. racemosus* and *B. arvensis.* It differs from both in the character of the spikelet at maturity, the florets being much spreading and the margin of the flowering glume being strongly involute.

2. **BROMUS RACEMOSUS** L. Sp. Pl. ed. 2. **1**: 114. 1762. *Serrafalcus racemosus* Parl. Rar. Pl. Sic. **2**: 14. 1840. (Fig. 2.)

An annual or biennial, with erect or ascending culm 3–7 dm. high, *usually scabrous-puberulent just below the panicle* and pubescent at the nodes. *Sheaths rather densely pilose-pubescent, at least the lower ones;* ligule about 1 mm. long, lacerate-dentate; blades linear, rather narrow, mostly 7–14 cm. long, pilose-pubescent below or on both surfaces. *Panicle typically simple* sometimes with 2–3 branches below, mostly somewhat nodding. Spikelets 15–20 mm. long, usually drooping in fruit, at first ovoid-lanceolate, becoming somewhat oblong-lanceolate, *always acute,* mostly 5–9-flowered; empty glumes broad, smooth or scabrous, the lower 3–5-nerved, 5–6 mm. long, the upper broader, 5–7-nerved, 6–8 mm. long; flowering glume elliptical, smooth, or scabrous, 7-nerved, 6–8 mm. long, very shortly bidentate at the apex, with a straight awn 5–8 mm. long inserted about 1 mm. below the apex; *palea shorter than its glume.* Introduced from Europe.

Specimens examined.—*Cape Breton Island:* New Campbellton (D. White and Chas. Schubert 28). *Maine:* Foxcroft (M. L. Fernald 565). *Pennsylvania:* Bucks Co. (N. L. Britton); Philadelphia (C. E. Smith 41). *Delaware:* Centreville (A. Commons 137).

The validity of this species is uncertain. The only thing in Linnæus's original description to distinguish it from other closely related forms is the following: "Panicula constat racemo simplici: pedunculis alternis, sæpius solitarius . . . ."

We have for the present accepted the interpretation and emendation of the species as given by Mertens and Koch in "Rœhling's Deutschlands Flora 1[2]: 681." These authors state that the growing plant shows the greatest resemblance to *B. mollis.* It differs from that species, however, in its smooth spikelets and looser panicle. From *B. secalinus* it is said to always differ in the fruiting condition in having the margins of the flowering glumes flat and overlapping, or but very slightly involute toward the base, instead of having the florets spread and the margins strongly involute. It is also said to flower earlier and have more pubescence on

leaves and sheaths. Much of the material in the herbarium hitherto referred to this species belongs to *B. racemosus commutatus* and *B. secalinus*, and the western material especially is in great part *B. hordeaceus glabrescens*, which is distinguished by its denser panicle with shorter branches.

2a. **BROMUS RACEMOSUS COMMUTATUS** (Schrad.) Hook. f. Stud. Fl. Brit. Isl. 451. 1870. *Bromus commutatus* Schrad. Fl. Germ. 353. 1806. *Serrafalcus commutatus* Bab. Man. Brit. Bot. 374. 1843.

An annual or biennial, 3–7 dm. high, typically with a rather small panicle, but frequently, under favorable conditions of growth, with a panicle as large as that of *B. secalinus*, but more drooping. It differs from the species in its rather larger spikelets and panicle, also rather broader flowering glumes with frequently a faint indication of an angle on the margin just above the middle. The spikelets 2–2.5 cm. long, 6–7 mm. wide, intermediate in size between *B. racemosus* and *B. squarrosus;* from the latter it differs in its straight awn also. From *B. arvensis* it is separated by its smaller drooping panicle and larger spikelets.

FIG. 2.—*Bromus racemosus: a,* lower portion of a spikelet; *b,* flowering glume, dorsal view.

This plant seems to be quite generally introduced throughout the country, and especially in the East.

SPECIMENS EXAMINED.—*Massachusetts:* Essex Co. (Oakes). *Connecticut:* Fairfield (E. H. Eames). *New York:* Ithaca (F. V. Coville). *Pennsylvania:* Easton (T. C. Porter). *Maryland:* Marshall Hall (C. L. Pollard 303). *Ohio:* Oberlin (A. E. Ricksecker); Painesville (W. C. Werner). *Tennessee:* Knoxville (A. Ruth). *Michigan:* Agricultural College (C. F. Wheeler). *Iowa:* (L. H. Pammel 909). *Missouri:* Sheffield (B. F. Bush 599). *Washington:* Pullman (A. D. E. Elmer 886); near Montesano (A. A. & E. G. Heller 3983). *Oregon:* Otis Creek (J. B. Leiberg 2338).

3. **BROMUS HORDEACEUS** L. Sp. Pl. 1: 77. 1753. *Bromus mollis* L. Sp. Pl. ed. 2. 1: 112. 1762. *Serrafalcus mollis* Parl. Fl. Ital. 1: 395. 1848. (Fig. 3.)

An erect or ascending annual or biennial *with a rather dense, erect panicle.* Culms about 2–8 dm. high, usually somewhat pubescent at the nodes. *Sheaths retrorsely soft pilose-pubescent;* ligule 1.5–2 mm. long, laciniate; blades linear, varying from

pilose-pubescent to nearly smooth, about 5–15 cm. long and 3–5 mm. broad. *Panicle contracted*, narrow-pyramidal, 5–10 cm. long by 2–4 cm. broad; branches somewhat spreading in flower. Spikelets 5–13-flowered, ovate-lanceolate, *becoming obtuse*, 12–15 mm. long by 4–6 mm. wide, with short pedicels; empty glumes broad, obtuse, *coarsely pilose or scabrous-pubescent*, the lower 3–5-nerved, 4–6 mm. long, the upper 5–7-nerved, 7–8 mm. long; flowering glume broad, obtuse, 7-nerved, coarsely pilose or scabrous-pubescent, rather deeply bidentate, margin and apex hyaline, 8–9 mm. long; awn *rather stout*, rough, flattened toward the base, straight at first, *frequently somewhat twisted when old*, about 6–9 mm. long; palea a little more than ¾ the length of its glume.

A species native in southern Europe, introduced into this country, where it is very abundant on the Pacific coast, having taken possession of vast areas of the deteriorated semiarid range lands. It is also found sparingly on the Atlantic coast from Maine to Virginia.

SPECIMENS EXAMINED.—*Maine:* N. Berwick (J. C. Parlin 567). *New York:* Aurora (F. V. Coville in 1885). *Pennsylvania:* Philadelphia (I. C. Martindale 13 and 14). *Delaware:* Centerville (A. Commons 133). *Ohio:* Oberlin (A. E. Ricksecker 1895). *Montana:* Garrison (P. A. Rydberg 2126). *Utah:* Ogden (T. A. Williams 2495). *Idaho:* Clear Water River (Sandberg, Heller, McDougal 167). *Washington:* Walla Walla (C. L. Shear 1585; E. P. Sheldon 8140); Tacoma (A. B. Leckenby in 1898); Cascade Mts. (G. R. Vasey in 1889; Sandberg & Leiberg 172); Seattle (C. V. Piper 796). *Oregon:* Lexington (J. B. Leiberg 10). *California:* San Francisco (M. E. Jones 3270); Marin Co. (Dr. E. Palmer 2032, 2033); Berkeley (J. W. Blankinship 64); Santa Cruz (Dr. Anderson in 1887); Morley Station (J. B. Davy 1894); San Jose (H. A. Brainard in 1896); Pitt River (H. E. Brown 224); Mt. Shasta (H. E. Brown 374b).

FIG. 3.—*Bromus hordeaceus:* a, empty glumes; b, flowering glume; c, palea.

There being nothing in the original descriptions of these species to separate them, we have adopted the older name on the authority of Munro, who states in his paper on "The Grasses of Linnæus's Herbarium"[1] that Linnæus's specimens of the two, *B. hordeaceus* and *B. mollis*, are the same.

3*a*. **BROMUS HORDEACEUS INTERMEDIUS** (Guss.) n. comb. *Bromus intermedius* Guss. Fl. Sic. Prod. **1** : 114. 1827. *Serrafalcus intermedius* Parl. Rar. Pl. Sic. **2** : 17. 1840.

This differs from the species only in its slightly larger panicle and spikelets and awns, which are twisted and divaricate when mature and dry.

[1] Proceedings of the Linnæan Society—Botany, **6**: 46. 1861.

Represented in the herbarium by a single specimen collected by Dr. L. D. Morse along a walk in San Mateo, California, June, 1898.

3β. **BROMUS HORDEACEUS GLABRESCENS** (Coss.) n. comb. *Bromus mollis glabrescens* Coss. Fl. Descr. Par. 654. 1845.

This differs from the species in having the spikelets glabrous or only scabrous throughout.

Like the species it is introduced on the east and west coasts.

SPECIMENS EXAMINED.—*Delaware:* Millsboro (A. Commons 132). *District of Columbia:* N. E. Washington (F. Blanchard). *California:* Marin County (Dr. E. Palmer 2033); New York Falls (G. Hansen 2080); San Francisco (Bolander). *Oregon:* Bonneville (W. M. Canby 26). *Washington:* Pullman (A. D. E. Elmer 876); no locality (E. P. Sheldon 8205 and G. R. Vasey).

FIG. 4.—*Bromus arvensis:* *a*, empty glumes; *b*, part of a spikelet with the lower florets open showing the paleæ.

4. **BROMUS ARVENSIS** L. Sp. Pl. 1: 77. 1753. *Serrafalcus arvensis* Parl. Fl. Ital. 1: 393. 1848. (Fig. 4.)

A tufted annual or biennial, somewhat geniculate at the base. Culm nearly or quite glabrous, about 3–6 dm. high. *Sheaths densely soft pubescent;* ligule about 2 mm. long, lacerate; blades linear, pubescent both sides. Panicle effuse, broad, apex somewhat drooping; *lower rays mostly 4–8.* Spikelets terete-acuminate at first, becoming slightly laterally compressed when old, about 7–11-flowered, 1.5–2.5 cm. long, 3–4 mm. broad, smooth or minutely scabrous throughout; empty glumes broad; the lower subacute 3–5-nerved, 4–5 mm. long; the upper about 7-nerved, obtuse, 5–6 mm. long; flowering glume 7–8 mm. long, broad, *obtuse with the broad hyaline margin projecting slightly into an obtuse angle just above the middle;* apex hyaline, emarginate; awn inserted below the apex, 7–10 mm. long, *straight or slightly twisted when old;* palea shorter than its glume.

Type from Europe.

Introduced into this country in a few localities. Dr. Beal, in "Grasses of North America," reports it from New Jersey and Michigan. The only American specimens we have seen are the following: *Missouri:* Sheffield, common along railroads (B. F. Bush 577 and 588).

This can scarcely be satisfactorily separated from *B. patulus* M & K., which see for the points of difference usually noted. It is also close to *B. racemosus commutatus.*

5. **BROMUS PATULUS** M. & K. in Roehl. Deutsch. Fl. 1: 684. 1823. *Serrafalcus patulus* Parl. Fl. Ital. 1: 394. 1848. (Fig. 5.)

An annual or biennial with culms smooth, erect, or somewhat geniculate at the base, about 4–6 dm. high. Sheaths softly pubescent; ligule 2–3 mm. long, subtruncate, laciniate-dentate; blades linear-lanceolate, pubescent throughout. Panicle 12–20 cm. long, very broadly pyramidal, diffuse, somewhat drooping; *lower branches 3–5*, slender, smooth; spikelets on slender pedicels, drooping, lanceolate to ovoid-lanceolate, terete at first, 2–2.5 cm. long, 5–6 mm. broad, becoming somewhat laterally compressed at maturity, smooth throughout; empty glumes rather broad, the lower narrower, acute, 3-nerved, 4–6 mm. long; the upper obtuse, *5-nerved, 6–8 mm. long;* flowering glume 9-nerved, the marginal ones faint, 7–9 mm. long, broad, obtuse, *with a hyaline margin obtusely angled above the middle and an emarginate apex;* awn 8–10 mm. long, stout, *somewhat twisted and strongly divaricate at maturity*, inserted below the apex; palea conspicuously shorter than its glume.

Type from Austria.

Introduced in this country in a few places.

SPECIMENS EXAMINED. — *Massachusetts:* waste ground, Boston (C. W. Swan). *South Dakota:* Brookings (T. A. Williams). *Colorado:* Fort Collins (L. H. Pammel).

A species intermediate between *B. arvensis* and *B. squarrosus.* From the former it is distinguished by its somewhat larger, more compressed spikelets, rather stouter awn, strongly divergent at maturity, and earlier flowering period. From the latter it is distinguished by its narrower spikelets, larger panicle, and less conspicuous angle at the margin of the flowering glume. Perhaps but a variety of *B. arvensis.*

FIG. 5.—*Bromus patulus:* a, empty glumes; b, flowering glume.

6. **BROMUS SQUARROSUS** L. Sp. Pl. 1: 76. 1753. *Serrafalcus squarrosus* Bab. Man. Brit. Bot. 375. 1843. (Fig. 6.)

A more or less tufted annual, 2–4 dm. high with a short, somewhat nodding panicle and densely soft pilose sheaths. Culms erect or slightly geniculate at the base, smooth. Sheaths densely retrorsely pilose-pubescent; ligule about 1 mm. long; blades linear, about 8–15 cm. long, 3–5 mm. wide, softly pubescent on both sides. Panicle *usually 6–12 cm. long*, open, branches ascending or drooping, frequently flex-

uous. Spikelets oblong to oblong ovoid, turgid, 6–12-flowered, 15–20 mm. long; empty glumes broad, obtuse, glabrous, the lower 3- or indistinctly 5-nerved, $\frac{2}{3}$–$\frac{3}{4}$ the length of the upper, the upper 7–9-nerved, 6–8 mm. long; flowering glume *very broad, 7–9-nerved, obtuse*, with a broad scarious margin somewhat obtusely angled above the middle, glabrous or minutely scabrous, apex minutely notched; awn *rather stout, attached below the apex*, about the length of the glume, *somewhat twisted and divergent, especially at maturity;* palea a little shorter than its glume.

Adventive from Europe. Has been found in waste places on the eastern coast sec. Britton and Brown, "Illustrated Flora."

Type in Linnæus's herbarium.

Specimens examined: A single specimen in the National Herbarium collected at Lansingburg, New York, by Dr. E. C. Howe in 1886, has been referred to this species, though it is not typical but approaches very closely *B. secalinus* and *arvensis*.

Fig. 6.—*Bromus squarrosus:* a, lower portion of a spikelet; b, dorsal view of a flowering glume.

7. BROMUS BRIZÆFORMIS Fisch. & Mey. Ind. Sem. Hort. Petrop. 3: 30. 1837. (Fig. 7.)

An erect annual with rather slender culms and *large drooping, brizæform spikelets.* Culms about 3–6 dm. high, smooth or slightly pubescent at the nodes. Sheaths with a soft, short-pilose pubescence, especially the lower ones; ligule about 2 mm. long, somewhat laciniate; blades linear, usually pubescent on both sides. Panicle 5–25 cm. long, lax, secund, mostly nodding. *Spikelets about 15–25 mm. broad*, oblong-ovoid, *laterally much compressed;* empty glumes broad, obtuse, smooth or minutely scabrous, frequently purplish, lower 3–5-nerved, about one-half the length of the upper, which is broader, 5–9-nerved and 6–8 mm. long; flowering glume about 1 cm. long, *very broad*, obtuse, smooth or slightly scabrous, with a broad scarious margin; awn none or sometimes present, especially on the upper flowering glumes, terminal, 1–2 mm. long; palea not quite equaling the glume, sparsely pectinate-ciliate on the keels.

Introduced. Most frequently met with on the west coast.

Type locality "in montibus Talüsch." (Caucausus Region?)

Specimens examined.—*Massachusetts* (ex herb. W. P. Alcott in 1880). *New York:* Ithaca (W. R. Dudley in 1884). *Delaware:* Wilmington (A. Commons 339 in 1898). *Montana:* (F. Lamson-Scribner 97 in 1883). *Idaho:* Lewiston (A. A. & E. G. Heller 3203 in 1896; L. F. Henderson 4635 in 1894); Viola (Sandberg, Heller & McDougal 482 in 1892); Cœur d'Alene Mountains (J. B. Leiberg 1006 in 1895). *Utah:* Echo (P. A. Rydberg 2353 in 1895); Salt Lake City (L. H. Pammel 197 in 1899). *Nevada:* Reno (S. M. Tracy 194 in 1887). *Washington:* Waitsburg (R. M. Horner 563 in 1897); Pullman (A. D. E. Elmer 371 in 1896; 876 in 1897); Wawawai (C. V. Piper 1739 in 1894). *Oregon:* Prineville (J. B. Leiberg 308 in 1894). *California:* Near Mount Shasta (Dr. E. Palmer 2647 in 1892).

8. **BROMUS SCOPARIUS** L. Cent. Pl. **1**: 6. 1755. *Serrafalcus scoparius* Parl. Fl. Pal. **1**: 174. 1845. (Fig. 8.)

An annual with rather slender, smooth, nearly erect culms about 2–3 dm. high. Sheaths sparsely pilose or nearly smooth; ligule about 1 mm. long, laciniate-dentate; blades linear, 6–12 cm. long, mostly pilose above and smooth beneath. Panicle *dense, oblong or ovate, obtuse, erect, 3–6 cm. long, 1–3 cm. broad;* branches *very short.* Spikelets very short-pedicellate, oblong-lanceolate, 5–11-flowered, 10–18 mm. long; empty glumes glabrous or slightly scabrous on the nerves, the lower acute, 1–3-nerved, 4–5 mm. long, the upper 3-nerved, broader, 5–6 mm. long; flowering glume 7–8 mm. long, 5-nerved, varying from typically smooth to sometimes scabrous-pubescent, bidentate at the membranous apex; *awn twisted, divaricate, 7–8 mm. long inserted 1.5–2 mm. below the apex;* palea about 1 mm. shorter than its glume with the keels remotely ciliate-pectinate.

Fig. 7.—*Bromus brizæformis: a,* a spikelet; *b,* empty glumes; *c,* flowering glume; *d,* palea.

Type from Spain.

Indigenous in the Mediterranean region of Europe and Africa, adventive in California.

We have only one specimen in the herbarium, collected by J. W. Congdon, at Mariposa, California.

II. NEOBROMUS n. subgen.

Flowering glumes lanceolate, deeply bifid; awn twisted and bent below the middle.

The following species is the type of this subgenus:

9. **BROMUS TRINII** Desv. in Gay Fl. Chil. **6**: 441. 1853. *Trisetum hirtum* Trin. Linnæa, **10**: 300. 1835. Not *B. hirtus* Lichtst. 1817. *Trisetum barbatum* Steud.

Syn. Pl. Gram. 229. 1854. *Bromus barbatoides* Beal, Grass. N. A. **2**: 614. 1896. *Avena symphicarpi* Trin. mss. (p. p.) sec. Desvaux l. c.. (Fig. 9.)

An erect cæspitose annual, usually branching below, mostly 3–6 dm. high. Culm smooth or pubescent at the nodes. Sheath usually pilose-pubescent, sometimes nearly smooth; ligule rounded or subtruncate, dentate, about 1 mm. long; blades linear to linear-lanceolate, 6–15 cm. long, 3–5 mm. wide, mostly pilose-pubescent throughout, sometimes nearly smooth. Panicle usually narrow and somewhat crowded, suberect, 8–20 cm. long; branches rather numerous, slender, ascending or diverging in fruit. Spikelets narrow, lanceolate at first, becoming spread and oblong lanceolate in flower and fruit, *mostly 5–7-flowered*, 1.5–2 cm. long; empty glumes lanceolate, acuminate, or with a subulate prolongation, smooth, the lower 1-nerved, rarely 3-nerved, 8–11 mm. long, the upper broader, 3-nerved, rarely 5-nerved, 13–16 mm. long; flowering glume *coarsely and subsparsely pubescent*, 5-nerved, 12–15 mm. long, *acuminate, with two narrow teeth 2–3 mm. long;* the pubescence on the callus is usually slightly denser and longer than on the glume; awn *15–20 mm. long, twisted below, bent below the middle and strongly divaricate when old.*

FIG. 8.—*Bromus scoparius*: *a*, empty glumes; *b*, portion of a spikelet, showing flowering glumes.

Type from Chile.

General distribution: California to Colorado and south to Chile.

SPECIMENS EXAMINED.—*Utah:* Sitgreaves Pass, Camp 60 (Ives Expedition). *Nevada:* Near Horse Spring (M. E. Jones 5069f); valley of Virgin River, Lincoln County (Coville & Funston 1907). *California:* Los Angeles (S. M. Tracy 163; Kellogg & Harford 1087, 1094); near Pasadena (O. D. Allen, April 12, 1885); Panamint Mountains, Inyo County (Coville & Funston 506); near San Francisco (Bolander 6128).

This plant is apparently related to *B. scoparius* and *B. tectorum*, though differing in some respects from all species of *Bromus* and showing close relationship with *Trisetum* and *Avena*, to both of which genera forms of it have been referred. It appears to us, however, nearest to *Bromus* by reason of its rather large numerous flowered spikelets, nearly closed sheath, and plicate grain adhering to the palea.

9a. BROMUS TRINII PALLIDIFLORUS Desv. in Gay Fl. Chil. **6**: 441. 1853. *Bromus barbatoides sulcatus* Beal, Grass. N. A. **2**: 615. 1896. *Trisetum barbatum major* Vas. in herb. and Beal l. c.

A more robust and larger plant, 6–12 dm. high, with a much elongated panicle mostly 2–4 dm. long; with branches mostly 6–12 at the lower whorls, weak and spreading; leaves broadly linear lanceolate, smooth or somewhat sparsely pilose-pubescent, as are also the sheaths.

Type from the Andes of southern Chile.

General distribution: Southern California to southern Chile.

SPECIMENS EXAMINED.—*California:* Near Pasadena (O. D. Allen in 1885); Chollos Valley, San Diego (C. R. Orcutt 1064); San Diego (D. Cleveland in 1882); San Nicholas Island (Blanche Trask 15).

9β. BROMUS TRINII EXCELSUS n. var.

A stout perennial (?) 5–7 dm. high. Leaves and sheaths short pilose-pubescent. Panicle rather narrow, nearly erect 1.5–2 dm. long; branches numerous, ascending, 2–8 cm. long. Spikelets *oblong-lanceolate, carinate,* 2–2.5 cm. long, *5–6 mm. wide;* empty glumes lanceolate-acuminate, smooth, the lower 3-nerved, 13–15 mm. long; flowering glume *7-nerved, 10–12 mm. long,* sparsely pilose-pubescent, bidentate at the acute apex; teeth 1–2 mm. long; *awn 10–12 mm. long,* somewhat twisted at the base, and divaricate.

Type No. 522, collected by Coville & Funston in the Panamint Mountains, Inyo County, California; altitude 1,700 m.

This plant, which is the only one of this form seen, is somewhat anomalous and may prove to be a good species. The spikelets and glumes are conspicuously wider than in the species, the florets more crowded, and the awn shorter.

FIG. 9.—*Bromus trinii:* a, empty glumes; b, portion of a spikelet showing flowering glumes.

III. STENOBROMUS Griseb.

Annual or biennial plants, with mostly narrow spikelets and glumes and rather long awns. Chiefly natives of the Mediterranean region of Europe and Africa. Introduced in this country.

10. BROMUS MADRITENSIS L. Cent. Pl. **1** : 5. 1755. (Fig. 10.)

A tufted annual, with an erect, rather dense panicle. Culm 3–7 dm. high, erect or somewhat geniculate at the base, smooth. Sheaths smooth or the lower slightly pubescent; ligule about 2 mm. long, subtruncate and lacerate; blades linear, puberulent or nearly smooth, 5–15 cm. long, 2–4 mm. wide. Panicle *erect, 5–12 cm. long, oblong-ovoid in outline,* lower branches 2–4, 1–3 cm. long, unequal, some-

what spreading in flower, slender and somewhat swollen at the base of the spikelets. Spikelets *3–4 cm. long* exclusive of awns, nearly smooth to scabrous-puberulent, 7–11 flowered; empty glumes lanceolate, acuminate, the lower 1-nerved, 9–12 mm. long, the upper 3-nerved, 13–16 mm. long; flowering glume linear-lanceolate, *15–18 mm. long,* usually glabrous or merely scabrous, somewhat curved outward when old, distinctly 3 or faintly 5–7-nerved, with two acute hyaline teeth, 2–3 mm. long, *and a rather stout, tapering, rough, somewhat curved awn about 16–22 mm. long;* palea reaching about to the point of the insertion of the awn, pectinate-ciliate on the keels.

A species introduced from Europe rather widely distributed in California and reported from Michigan by Beal in "Grasses of North America."

SPECIMENS EXAMINED.—*California:* San Jose (H. A. Brainard); near Antioch (J. Burtt Davy 111); Ft. Tejon (S. B. Parish 1994); New York Falls, Amador County (Geo. Hansen 2123).

FIG. 10.—*Bromus madritensis: a,* empty glumes and two lower florets; *b,* flowering glume with part of the awn.

11. BROMUS MAXIMUS Desf. Fl. Atl. 1: 95. *t. 26.* 1798. (Fig. 11.)

An erect or ascending annual, 2–4 dm. high, with a smooth culm. Sheaths pilose-pubescent; ligule 3–4 mm. long, rounded above, lacerate; blades flat, linear, 3–5 mm. broad and about 2–3 dm. long, pilose both sides. Panicle erect, somewhat secund and narrow, open in flower, closing more or less afterwards, 5–10 cm. long, lower branches 2–3, about 1.2 cm. long, bearing 1–2 spikelets. Spikelets *usually 5–7-flowered,* 3.5–5 cm. long, exclusive of the awns, terete or somewhat laterally compressed at maturity; empty glumes smooth, lanceolate, acuminate, the lower 15–20 mm. long, strongly 1-nerved, margin hyaline, the upper broader, 25–30 mm. long, prominently 3-nerved; flowering glume 5-nerved, *25–30 mm. long,* harshly scabrous to scabrous-puberulent, 2-toothed at the apex; teeth hyaline, acute, about 3–4 mm. long, awn *stout, 3.5–4.5 cm. long,* very rough, tapering toward the end, inserted just below the teeth; palea somewhat shorter than its glume; rachilla slender, puberulent, about 3 mm. long.

Type from northern Africa

SPECIMENS EXAMINED.—*California:* Stanford University (C. Ritter 305); (J. B. Davy in 1894).

There are several names antedating the above which are regarded by some European authorities as synonymous. *B. rigidus* Roth, Roem. & Ust. Mag. Bot. **10**: 21. 1790 is one. This has been adopted by Dr. Beal (Grass. N. A. **2**: 611. 1896). A careful study of the original description of this species, however, leads us to believe that the plant should at least be separated as a variety. The following quotations from Roth's description l. c. indicate the chief points of difference: "Culmi . . primus erecti, demum procumbentes, panicula . . spiculis . . 10 ad 12 floribus compositis; corollæ valvula exterior . . hirsuta."

The most important difference between our plants as well as the European specimens examined and the above description is in the hirsute flowering glume. Mertens and Koch in Roehl. Deutsch. Fl. **1**: 689. 1823, say that they received a specimen from Roth himself having smooth spikelets, thus showing that he regarded such forms as belonging to his species. Notwithstanding this these authors, l. c., p. 691, regard *B. maximus* as at least varietally separate from *B. rigidus*, so it seems to us best to retain for the present for our plant Desfontaine's name. *Bromus incrassatus* Lam. Enc. **1**: 468. 1783, and *B. rigens* L. Mant. **1**: 33. 1767, are also doubtful synonyms.

11*a*. **BROMUS MAXIMUS GUSSONI** Parl. Fl. Ital. **1**: 407. 1848. *Bromus gussoni* Parl. Rar. Pl. Sic. **2**: 8. 1840. *Bromus sterilis* Guss. Fl. Sic. Prod. Suppl. **1**: 27. 1832. Not L. 1753.

Differs from the species in its larger size, 4–7 dm. tall, larger and more lax panicle, 1–2 dm. long, with the upper part somewhat drooping.

An introduced plant occurring in Arizona, California, and Washington.

Fig. 11.—*Bromus maximus: a*, empty glumes with a floret; *b*, flowering glume with portion of the awn.

Specimens examined.—*Arizona:* Near Fort Huachuca (T. E. Wilcox 172); Huachuca Mt. (J. G. Lemmon and wife 3107). *California:* Avalon, Santa Catalina Island (Blanche Trask in 1898); San Francisco (Bolander); San Jose (H. A. Brainard, in 1896); San Diego (C. R. Orcutt 1059); Woodland (J. W. Blankinship 39 and 40); Berkeley County (J. W. Blankinship 38); Clear Creek, Butte County (H. E. Brown 199); Chico (E. Palmer 2034); New York Falls, Amador County (G. Hansen 598); near San Bernardino (J. B. Leiberg 3323). *Washington:* Tacoma (A. B. Leckenby in 1898).

12. BROMUS RUBENS L. Cent. Pl. **1**: 5. 1755. *Festuca rubens* Pers. Syn. Pl. **1**: 94. 1805. (Fig. 12.)

A rather slender, tufted annual. Culm about 2–5 dm. high, erect or slightly geniculate at the base, puberulent toward the top. Sheaths pubescent, ligule 1–2 mm. long, laciniate-dentate; blades 3–15 cm. long, linear-lanceolate, pubescent both sides. Panicle *erect, compact, ovoid, usually purplish, about 4–7 cm. long.* Spikelets mostly 7–11-flowered, *2–2.5 cm. long;* empty glumes acuminate, smooth to scabrous, pubescent, the lower narrow, 1-nerved, 7–9 mm. long, the upper broader, 3-nerved, 10–12 mm. long; flowering glume *13–16 mm. long,* lanceolate acute, 5-nerved, scabrous to appressed, scabrous-pubescent, somewhat bent outward when mature, *apex deeply cleft into two long-acuminate hyaline teeth 4–5 mm. long; awn straight, 18–21 mm. long;* palea reaching about to the point of insertion of the awn, long ciliate-pectinate on the keels.

FIG. 12.—*Bromus rubens:* *a*, empty glumes; *b*, portion of a spikelet showing flowering glume with portion of the awn, also the palea.

A species from the Mediterranean region of Europe introduced on the Pacific coast and reported by Beal as being found in Kansas. A single specimen has been seen from the Atlantic coast on wool waste near Boston, Mass.

SPECIMENS EXAMINED.—*California:* Volcano, Amador County (George Hansen 2078); near Santa Ana (A. Davidson 1973); Santa Catalina Island (Blanche Trask 12; T. A. Brandegee); Berkeley (J. W. Blankinship 36); Capay (J. W. Blankinship 37). *Oregon:* Gilliam County (J. B. Leiberg 163). *Massachusetts:* N. Billerica (C. W. Swan).

This species is closely related to *B. madritensis,* but is smaller throughout and has a more compact panicle.

13. BROMUS STERILIS L. Sp. Pl. **1**: 77. 1753. *Schedonorus sterilis* Fr. Summ. Veg. Scand. **1**: 76. 1846–49. (Fig. 13.)

An annual or biennial with rather stout, smooth, erect or ascending culms, 5–10 dm. high, more or less geniculate or curved at the base. Sheaths mostly pubescent; ligule 1–1.5 mm. long, laciniate; blades broadly linear, usually pubescent throughout. Panicle *1–2 dm. long, broad, lax, drooping; lower branches 2–6,* long and slender, rarely bearing more than one spikelet. Spikelets *drooping, 2.5–3.5 cm. long,* 6–10-flowered, linear-elliptical before flowering, becoming oblong and enlarged upward during flowering, and finally oblong-cuneiform with flattened sides and subdistant florets; empty glumes lanceolate-subulate, smooth or scabrous, the lower 1-nerved, 7–9 mm. long, the upper 3-nerved, 11–13 mm. long; flowering glume *linear-lanceolate, 5–7-nerved, 17–20 mm. long,* scabrous or scabrous-puberulent, deeply bidentate; teeth hyaline, subulate, about 2 mm. long; awn *stout, tapering, very rough, 2–3 cm. long;* palea considerably shorter than its glume.

A species introduced from southern Europe, quite frequent on the Atlantic and Pacific coasts.

SPECIMENS EXAMINED.—*Massachusetts:* Boston (C. W. Swan). *New York:* Taughannock (K. M. Wiegand; F. V. Coville). *Pennsylvania:* Easton (A. P. Garber; T. C. Porter); Philadelphia (C. E. Smith 40). *Delaware:* Wilmington (A. Commons 17). *District of Columbia:* North Brookland (T. Holm). *Ohio:* Painesville (W. C. Werner). *British Columbia:* Vancouver Island (J. Macoun 117). *Washington:* Pullman (C. V. Piper 2554); Walla Walla (C. L. Shear 1616).

14. **BROMUS TECTORUM** L. Sp. Pl. 1: 77. 1753. *Schedonorus tectorum* Fr. Summ. Veg. Scand. 1: 76. 1846–49. (Fig. 14.)

A tufted annual mostly 3–6 dm. high, erect or somewhat geniculate at the base. Culm smooth, rather slender. Sheaths pubescent; ligule membranous, 2–3 mm. long, much torn; blades linear, narrow, mostly pubescent throughout. Panicle *broad, rather dense, secund, drooping, about 6–15 cm. long, branches subcapillary.* Spikelets nodding, linear at first, spreading above in flower and becoming cuneiform, *13–20 mm. long;* empty glumes acute, scabrous or pubescent, the lower narrow, 1-nerved, 4–6 mm. long, the upper 3-nerved, broader, 8–10 mm. long; flowering glume lanceolate, acute, scabrous-pubescent to short pilose-pubescent, 5-nerved, 11–13 mm. long with two narrow hyaline teeth at the apex and *a straight awn about 13–15 mm. long;* palea shorter than its glume.

A species from Europe quite generally distributed in this country, especially in waste places about cities.

FIG. 13.—*Bromus sterilis: a,* Empty glumes and a floret; *b,* dorsal view of a flowering glume with portion of the awn.

SPECIMENS EXAMINED.—*Massachusetts:* Cambridge (J. W. Blankinship; A. K. Harrison 28); Essex County (W. P. Conant). *Rhode Island:* Providence (J. F. Collins). *New Jersey:* Weehauken (Wm. N. Van Sickle). *Pennsylvania:* Easton (T. C. Porter). *Delaware:* Wilmington (A. Commons 16). *District of Columbia:* Washington (C. L. Pollard 426). *Virginia:* Alexandria (T. Holm). *Indiana:* Pine (L. M. Umbach). *Mississippi:* Starkville (S. M. Tracy 1746). *Colorado:* Fort Collins (E. D. Ball; C. S. Crandall 526). *Utah:* Ogden (T. A. Williams 2496); Provost (M. E. Jones 5503). *Washington:* (Sandberg & Leiberg 191); Pasco (A. D. E. Elmer 1047).

This species is nearly related to *B. sterilis,* but is much smaller in every way and has a denser panicle.

IV. ZERNA Panz. emend.

Nearly all native short-lived perennials, with but few exceptions, having a weak drooping panicle and more or less pubescent flowering glumes, frequently with the pubescence unevenly distributed.

A. *Panicle lax and drooping.*

15. BROMUS RAMOSUS Huds. Fl. Angl. ed. 1. 40. 1762. *Bromus asper* Murr. Prod. Stirp. Gött. 42. 1770. (Fig. 15.)

FIG. 14.—*Bromus tectorum*: *a*, Empty glumes; *b*, portion of a spikelet showing flowering glumes and portion of the awns.

A rather stout, erect, loosely cæspitose perennial with a rather long, loose, nodding panicle. Culms about 10–15 dm. high, smooth or slightly rough pubescent just below the nodes, rather slender. Sheaths shorter than the internodes, *clothed with abundant, rather stiff subretrorse hairs;* ligule *about 2 mm. long,* laciniate; blades broadly linear, about 2–3 dm. long and 8–12 mm. wide, sparsely pilose on the nerves beneath, harshly scabrous or subpilose above. Panicle 2–3 dm. long, open, loose, the branches distant, usually drooping. Spikelets about 6–10-flowered, narrow, *2–3 cm. long;* empty glumes narrow, scabrous on the nerves, lower 1-nerved, a little more than one-half the length of the upper, upper 3-nerved, acute or mucronate, 9–11 mm. long; flowering glume *12–15 mm. long,* acute, two-toothed at the apex, scarious margined, distinctly 3-nerved, *scabrous on the nerves,* shortly hispid from the outer nerves to the margin and on the lower portion of the keel; awn slender, straight, *7–9 mm. long;* palea *a little more than three-fourths the length of its glume,* ciliate-pectinate on the keels.

A species introduced from Europe. It is said in Britton and Brown's "Illustrated Flora" to be distributed from New Brunswick to Michigan and Kentucky. We have no American specimens in the National Herbarium, and have drawn the above description from European material. Dr. H. Trimen (Journ. Bot. **8**: 376. 1870) has been followed in adopting Hudson's name for this plant, which does not seem to have been different from Murray's. (Cf.. Dr. Trimen l. c. for further synonymy.)

This species is very closely related to *B. ciliatus* and has possibly been confused with it. It is usually distinguished by its rougher pilose-hispid sheaths and longer flowering glume and awn. The panicle is usually looser and with fewer spikelets.

16. **BROMUS CILIATUS** L. Sp. Pl. 1: 76. 1753. *Bromus canadensis* Mx. Fl. Bor. Am. 1: 65. 1803. (Fig. 16.)

A tall, rather slender, leafy perennial with a broad, lax, drooping panicle. Culms erect, smooth or slightly pubescent at the dark nodes, about 7–12 dm. high. Sheaths retrorsely short-pilose or nearly smooth, coarsely striate; ligule *very short, rarely exceeding 1 mm.;* blades *rather broadly linear-lanceolate,* weak, about 2.5–3.5 dm. long and 1 cm. broad, *typically sparsely pilose on both sides,* but sometimes almost smooth. Panicle very broadly pyramidal, about 1.5–2.5 dm. long; lower branches 2–4 long, slender, flexuous, drooping. Spikelets narrow, 5–9-flowered, 15–22 mm. long on slender, flexuous pedicels; empty glumes narrow, smooth; the lower 1-nerved, acute, 5–8 mm. long; the upper broader, obtuse, 8–11 mm. long, 3-nerved; flowering glumes narrow, oblong-lanceolate, obtuse and slightly bifid at the apex, distinctly 3 or faintly 5–7-nerved, *ciliate-pubescent on each side from the outer nerve to the margin for about three-fourths the length, 10–12 mm. long;* awn slender, straight, 3–5 mm. long; palea narrow, nearly equaling the glume; rachilla slender, thinly pubescent.

General distribution: Newfoundland to New York, west to Manitoba and Minnesota.

Type grown at Upsala, Sweden, from seed sent from Canada by Kalm.

FIG. 15.—*Bromus ramosus:* a, Empty glumes; b, the florets.

SPECIMENS EXAMINED.— *Newfoundland:* Shoal Point (A. Waghorne 49); Chimney Cove (A. Waghorne 48); Exploits River (Robinson and Schrenk in 1894). *Northwest Territory:* Severn River (J. M. Macoun in 1886). *Manitoba:* Brandon (J. M. Macoun 13042). *Maine:* East Auburn (E. D. Merrill 18, 24, 33, 34); ex herb. M. S. C. (Jackman 6); Van Buren (M. L. Fernald 195); Cape Elizabeth (E. E. Gayle 873). *New Hampshire:* Jaffrey (B. L. Robinson 336). *Vermont:* Manchester (M. A. Day 214, 217). *Massachusetts:* Ipswich (Oakes). *New York:* McKenzie Pond (C. H. Peck 9); South Branch (F. Tweedy in 1879); (W. R. Dudley in 1884); Lebanon Springs (A. K. Harrison 44); Oriskany (Geo. Vasey in 1841). *Michigan:* Keweenaw Point (F. E. Wood 3515); Rochester (O. A. Farwell 536a—a small form). *Wisconsin:* Tomahawk (L. S. Cheney 2198). *Minnesota:* (F. F. Wood 1889).

Linnaeus's good description of this species leaves little chance for doubt as to the identity of the plant. According to Dr. Gray, *Bromus kalmii* in Linnaeus's her-

barium is labelled *B. ciliatus*, and this fact led to some confusion by Muhlenberg and Torrey. Our plant is very closely related to *B. ramosus*. In the Black Hills, Manitoba, and Northwest Territory it passes by various intermediate forms through *B. richardsoni pallidus* into *B. richardsoni*. It is also connected by various gradations with *B. purgans*, so that like nearly all of our species it can only be separated arbitrarily.

16*a*. **BROMUS CILIATUS LÆVIGLUMIS** Scribn. in herb. n. var.

This differs from the species chiefly in having the flowering glumes entirely smooth or with a very slight amount of pubescence on the margin at the base. The type specimen has a somewhat narrower and less drooping panicle than the species, but other plants referred to below have about the typical *B. ciliatus* panicle.

Type collected by W. Herriott, Galt, Ontario, Canada, July, 1898.

SPECIMENS EXAMINED.—*Maine:* Dead River (Fernald & Strong 488). *North Carolina:* Magnetic City (A. G. Weatherby 197 and 140); Swain County (Beardslee & Kofoid 9).

FIG. 16.—*Bromus ciliatus: a*, empty glumes; *b*, dorsal view of a flowering glume; *c*, palea.

17. **BROMUS RICHARDSONI** Link, Hort. Berol. **2**: 281. 1833. *Bromus purgans longispicata* Hook. Fl. Bor. Am. **2**: 262. 1840. *Bromus ciliatus scariosus* Scribn. U. S. Dept. Agr. Div. Agros. Bul. **13**: 46. 1898. (Fig. 17.)

An erect, robust, tufted, short-lived perennial, about 6–13 dm. high. Culm smooth. Sheaths typically smooth below and pilose at the throat, sometimes scantily pilose throughout; ligule truncate, lacerate, 1–2 mm. long; blades linear-lanceolate, 15–25 cm. long and about 5–12 mm. broad, *mostly scabrous above and glabrous beneath*. Panicle usually large, effuse, and drooping, about 15–25 cm. long. Spikelets drooping terete-acuminate at first, becoming oblong-lanceolate and laterally compressed, *mostly 2–3 cm. long*, 6–11-flowered; empty glumes smooth, the lower acuminate; 1-nerved or rarely with two faint lateral nerves, *8–10 mm. long;* the upper 3- or rarely 5-nerved, *9–12 mm. long*, obtuse, or inequilateral and mucronate; flowering glume obtuse, emarginate, 7-nerved, *12–15 mm. long. appressed ciliate-pubescent from the second nerve to the margin and nearly to the apex, also across the back at the base;* awn straight 3–5 mm. long; palea slightly shorter than its glume.

Type in the collection of the Royal Botanical Museum, Berlin, grown from seed sent by Dr. Richardson from western North America.

General distribution: Arizona and New Mexico, north in the mountains to British America.

SPECIMENS EXAMINED.—*Arizona:* Chiricahua Mountains (J. W. Toumey 31); Tucson (J. W. Toumey 752); San Francisco Mountains (J. G. Lemmon 3194); Rincon Mountains (G. C. Nealley 88). *New Mexico:* (Dr. G. Vasey); White Mountains (E. O. Wooton 332). *Utah:* Provo (S. M. Tracy 404); Aquarius Plateau (L. F. Ward 431); Mount Ellen (M. E. Jones 5684 bf); Alta (M. E. Jones 1132). *Colorado:* Georgetown (P. A. Rydberg 2381; C. L. Shear 610, 624½; S. M. Tracy 457); Marshall Pass (F. E. Clements 216; C. L. Shear 918); Breckenridge (C. L. Shear 1078); Sheep Horn Divide (Shear & Bessey 1541, 1539, 1548); Grand Lake (Shear & Bessey 1522); Durango (F. Tweedy 389); Ouray (C. L. Shear 1153); Buffalo Pass (Shear & Bessey 1433); Red Mountain (C. L. Shear 1204); West Mancos (Tracy, Earle & Baker 332); Dix (Tracy, Earle & Baker 4298); Upper La Plata (Tracy, Earle & Baker 987, 4303); Silver Plume (P. A. Rydberg 2466; C. L. Shear 679, 711); Buckeye canyon (G. H. French); Glenwood Springs (Shear & Bessey 1301); Robinson (C. L. Shear 1050); Red Cliff (Shear & Bessey 1281, 1284; Patterson 30); Florissant (T. A. Williams 2207); Pikes Peak (T. A. Williams 2222, 2173; Crandall & Cowen 542); Manitou (C. L. Shear 761); Cameron Pass (C. S. Crandall 116); McCoys (Shear & Bessey 1334); Villa Grove (C. L. Shear 877). *Wyoming:* Welcome (T. A. Williams 2668, 2673a); La Plata Mines (E. Nelson 5087); Sheep Mountain (T. A. Williams 2305); Cooper Hill (A. Nelson 4407); Battle Lake (A. Nelson 4022); Cement Creek, Big Horn Co. (F. Tweedy 67). *Yellowstone National Park:* Near Mammoth Hot Springs (F. H. Burgelhaus). *Montana:* Belt Mountains (F. L. Scribner 411); Hound Creek (F. L. Scribner 14).

FIG. 17.—*Bromus richardsoni:* *a*, empty glumes with two florets; *b*, dorsal view of a flowering glume.

Through the kindness of Dr. I. Urban we have been able to examine a part of the type of this species which has not heretofore been recognized by American botanists so far as we know. This species includes the great bulk of the material from the Rocky Mountains hitherto referred to *B. ciliatus*, into which it

passes in British America. It is distinguished in general from *B. ciliatus* by its denser panicle, usually smooth leaves and sheaths and broader, more obtuse flowering glume, with more pubescence. Forms also occur connecting it with *B. porteri*. An examination of a spikelet from Hooker's type of *B. purgans longispicata* l. c. collected by Drummond in the Rocky Mountains shows it to be the same as *B. richardsoni*.

17*a*. **BROMUS RICHARDSONI PALLIDUS** (Hook.) n. comb. *Bromus purgans pallidus* Hook. Fl. Bor. Am. **2**: 252. 1840.

This in its typical form is distinguished from the species by the *silky-villous margin of the flowering glume*, pale green, narrower spikelets, and smaller, denser panicle. The leaves are also usually less numerous and narrower.

Type in the herbarium of the Royal Gardens, Kew, England, collected by Drummond in the Rocky Mountains.

General distribution: Western Nebraska, Colorado, and Nevada north to the Arctic coast.

SPECIMENS EXAMINED.—*Nebraska:* near Mullen (P. A. Rydberg 1404). *Colorado:* Grand Lake (Shear & Bessey 1525); Villa Grove (C. L. Shear 879); Gunnison (S. M. Tracy 442). *Nevada:* E. Humboldt Mount (Watson 1328). *Oregon:* Fort Klamath (J. B. Leiberg 670); Wallowa (C. L. Shear 1819); (W. C. Cusick 1289); Powder River Mountains (C. V. Piper 2528). *Washington:* Loomiston (A. D. E. Elmer 559). *Idaho:* Beaver Canyon (P. A. Rydberg 2329). *Montana:* East Gallatin Swamp (P. A. Rydberg 3170); Manhattan (C. L. Shear 431); Madison River (P. A. Rydberg 2275); Spanish Basin (P. A. Rydberg 3114); Sheep Creek (P. A. Rydberg 3304); Columbia Falls (R. S. Williams 605). *Yellowstone National Park:* Slough Creek (F. Tweedy 589). *Wyoming:* Ten Sleep (T. A. Williams 2832). *South Dakota:* Sylvan Lake (David Griffiths 721); Rochford (P. A. Rydberg 1166). *Saskatchewan:* (J. Macoun 79); Prairie Albert (J. Macoun 13045). *Alberta:* near Banff (J. Macoun 26). *British Columbia:* Elk River (R. Kennicott). *Northwest Territories:* Fort Resolution (R. Kennicott).

The examination of a spikelet from the type specimen of this variety shows that it is intermediate between *B. richardsoni* and *B. ciliatus* and intergrades with both. Its denser panicle, fewer, narrower, and smoother leaves with the longer, silky pubescence of the flowering glume separate it in its typical form from the latter species. It sometimes resembles *B. porteri* in everything but the distribution and character of the pubescence of the flowering glume.

18. **BROMUS KALMII** A. Gray, Man. Bot. 600. 1848. *Bromus ciliatus* Muhl. Gram. 169. 1817. Not L. 1753. *Bromus purgans* Torr. Fl. N. Y. **2**: 468. 1843. Not L. 1753. (Fig. 18.)

An erect, rather slender perennial with a drooping panicle. Culm 5–9 dm. high, *usually pubescent just below the nodes.* Culms leaves about 3: sheaths usually shorter than the internodes, *moderately retrorsely pilose-pubescent, at least the lower ones;* ligule about .5 mm. long, truncate, laciniate; blades flat, broadly linear-lanceolate, 7–17 cm. long, 5–10 mm. broad, *usually sparsely pilose-pubescent both sides,* rarely nearly smooth or scabrous. Panicle small, rather crowded, 5–15 cm. long, average about 10 cm.; lower branches 2–3, very slender and somewhat flexuous, bearing 1–2 spikelets. Spikelets drooping, oblong-ovoid, closely 7–13-flowered, 1.5–2.5 cm. long, 5–6 mm. broad; empty glumes *coarsely pubescent, the lower linear-lanceolate, 3-nerved,* 5–6 mm. long, the upper broader, obtuse, *7–8 mm. long, 5-nerved,* the outer nerves sometimes indistinct; flowering glumes obtuse, emarginate, densely and coarsely silky-pubescent, 7-nerved, 8–10 mm. long; awn straight, 2–3 mm. long; palea a little shorter than the glume; joints of the rachilla pubescent, 1–1.5 mm. long.

Type: There seems to be no particular specimen designated as the type of this species by Dr. Gray. The sheet in the Gray herbarium, regarded as that upon which the original description was founded, contains portions of plants from three different localities, two from New York and one from Michigan, varying however but very little from each other. These were taken as the basis of the above description.

General distribution: New England to Minnesota.

SPECIMENS EXAMINED.—*New York:* Sodus Bay (O. E. Pearce in 1884); Ithaca (K. M. Wiegand in 1895; F. V. Coville in 1885). *Pennsylvania:* Easton (A. P. Garber in 1867 and 1868; T. C. Porter, in 1868, 1891, and 1897). *Wisconsin:* Valley of Wisconsin River (L. D. Cheney 2031); (Dr. G. Vasey in 1883); Madison (T. J. Hale in 18—). *Minnesota:* St. Cloud (E. V. Campbell 55 and 56); Turtle Lake (E. P. Sheldon in 1892); Zumbrota (E. A. Mearns 775); Lake Minnewaska (L. R. Moyer 1b).

FIG. 18.—*Bromus kalmii.*

19. BROMUS PORTERI (Coult.) Nash; *Bromus kalmii porteri* Coult. Man. Bot. Ry. Mt. Reg. 425. 1885; *Bromus porteri* Nash. Bul. Torr. Bot. Club, **22**: 512. 1895; *Bromus kalmii occidentalis* Vas. in Beal Grass. N. A. **2**: 625. 1896; *Bromus ciliatus montanus* Vas. in Beal Grass. N. A. **2**: 619. 1896. not *Bromus montanus* Retz. 1779; *Bromus kalmii* of most auct. amer.; *Bromus kalmii major* Vas. in herb. (Fig. 19.)

A tufted short-lived perennial with rather slender, erect culms about 5–9 dm. high, slightly puberulent toward the top and pubescent at the nodes, bearing from 3–4 leaves. Sheath scantily short pilose or smooth, usually shorter than the internodes; ligule 1 mm. or less long, truncate, dentate; blades of the culm about 7–14 cm. long by 3–5 mm. wide, linear-lanceolate, somewhat erect, *rather distant and usually scabrous*, those of the innovations longer and narrower. Panicle 8–20 cm. long, averaging about 12 cm., drooping, lower branches mostly 2–4, subcapillary. Spikelets terete-lanceolate before flowering, 2–2.5 cm. long, usually 7–9 flowered; empty glumes mostly obtuse, short-pubescent or sometimes nearly smooth, lower 5–7 mm. long, narrower, sometimes subacute, *usually 3-nerved but*

lateral nerves rather short, inconspicuous and sometimes wanting; the upper 7–9 mm. long, distinctly 3-nerved, obtuse; flowering glume 11–13 mm. long, broad-lanceolate, rather coarsely pubescent, apex hyaline, entire, or slightly emarginate; awn 2–4 mm. long, inserted just below the apex; palea mostly slightly shorter than its glume.

Type: The following specimens are cited with the original description l c. "Colorado, at Twin Lakes (Porter), Buffalo Peaks, and Sierra Madre Range (Coulter)."

Specimens from both the collections referred to have been seen and the above description based on them.

General distribution: Arizona and New Mexico north to Manitoba and west to Alberta. Found in its most characteristic form in the Rocky Mountains at an altitude of 2–3000 meters.

FIG. 19.—*Bromus porteri*: *a*, empty glumes with two florets; *b*, dorsal view of a flowering glume.

SPECIMENS EXAMINED. — *Arizona:* Huachuca Mountains (F. X. Holzner 2164); a large form not typical; Tucson (J. W. Toumey). *New Mexico:* Glorietta (G. R. Vasey). *Colorado:* Steamboat Springs (Alice Eastwood 20); Mancos (Tracy, Earle & Baker 104, 382, 432); Silverton (C. L. Shear 1216); West Mancos Canyon (Tracy, Earle & Baker 332); Fort Collins Gulch (L. H. Pammel); North Park (C. F. Baker 24, 49; C. S. Sheldon 177); Sheep Horn Divide (Shear & Bessey 1540); Red Dirt Divide, Routt County (Shear & Bessey 1350, 1355); Marshall Pass (S. M. Tracy 459; C. L. Shear 934); Garland (C. L. Shear 854; G. Vasey); Crested Butte (Alice Eastwood 10a); Robinson (C. L. Shear 1054); Durango (Tracy, Earle & Baker 986, 4302); West Cliff (C. L. Shear 993); Twin Lakes (John Wolfe 1155–6); Gunnison (S. M. Tracy 442); Harmons Lake (Tracy, Earle & Baker 4300). *Utah:* Fish Lake (M. E. Jones 5743); Bromide Pass (M. E. Jones 5699bb); Above Kings Meadows (L. F. Ward 313); Cashe Junction (C. L. Shear 597); Aquarius Plateau (L. F. Ward 431). *Wyoming:* Sundance (Griffiths 420, 423, 436, 946; T. A. Williams 2604); Little Missouri Buttes (D. Griffiths 584); Bear Lodge Mountains (T. A. Williams 2642); Wind River (W. H. Forwood); Evanston (G. W. Letterman 3; T. A. Williams 2395, 2424); Elk Mountain (A. Nelson 4083); Gros Ventre (F. Tweedy 66); Woods Landing (A. Nelson 3922, 3848); Meeteetse Creek (T. A. Williams 2879); Spread Creek (F.

Tweedy 63); Tongue River Basin (B. C. Buffum 5116); Hulett (D. G. Griffiths 924); Big Horn Mountains (W. H. Forwood); Little Laramie River (T. A. Williams 2239); Seminole Mountains (E. Nelson 4931); Sand Creek (A. Nelson 1105); Inyan Kara Creek (T. A. Williams 2581); Crazy Womans Creek (T. A. Williams 2734). *Idaho:* Beaver Canyon (P. A. Rydberg 2344); Snake River (G. W. Letterman 90). *Yellowstone National Park:* Yellowstone Lake (A. Nelson 6628); Cash Creek (F. Tweedy 588). *Montana:* Spanish Creek Basin (T. A. Williams 2050); Northern Pacific R. R. (F. Lamson-Scribner); Lima (C. L. Shear 566; P. A. Rydberg 2315); Barker (P. A. Rydberg 3361); Castle (P. A. Rydberg 3253); Spanish Creek (P. A. Rydberg 3047). *South Dakota:* Rochford (P. A. Rydberg 1165). *North Dakota:* Bottineau (M. A. Brannon 79, 87, 92); Devils Lake (C. A. Geyer). *Manitoba:* Brandon (J. Macoun 13049); Rapid City (J. Macoun 13047). *Assiniboia:* Moose Jaw (J. Macoun 13043). *Saskatchewan:* (J. Macoun 77). *Alberta:* Milk Rim Ridge (J. Macoun 13037).

This is the western expression of *B. kalmii*, and but for its geographical distribution, I should be inclined to regard it as a variety of that species into which it passes by way of Minnesota and Canada. It is usually distinguished from that species by its smooth, narrower leaves, and narrower, fewer-nerved, empty glumes. It is also connected by intermediate forms with *B. richardsoni.*

19 α. BROMUS PORTERI LANATIPES n. var.

In its typical form this is a robust plant whose most striking character is its densely soft-downy or woolly sheaths. The leaves are scabrous both sides and larger than in the species; the panicle mostly larger and denser with spikelets somewhat larger and the empty glumes merely scabrous on the nerves or quite smooth.

Type No. 739, collected by C. L. Shear, Idaho Springs, Colo.

General distribution: Southern California, Arizona, New Mexico, and Colorado.

SPECIMENS EXAMINED.—*California*: San Bernardino Mountains (S. P. Parish 253 & 2533a; S. B. & W. F. Parish 1535). These specimens not typical. *Arizona*: Dos Cabezas (J. D. Emersley); no locality (J. D. Emersley 8). *Colorado*: Boulder (G. W. Letterman 9); Idaho Springs (C. L. Shear 739; P. A. Rydberg 2490 & 2496); La Veta (C. L. Shear 811); Golden (G. W. Letterman 8); M. E. Jones 269); Trinidad (S. M. Tracy 12½); Walsenburg (C. L. Shear 799).

This variety passes by various forms into the species. It also closely approaches *B. richardsoni.* The specimens cited from southern California have the sheaths less densely pubescent and approach *B. lævipes.*

19 β. BROMUS PORTERI HAVARDII nom. nov. *Bromus ciliatus minor* Munro, Dewey in Contr. U. S. Nat. Herb. **2**: 548. 1894. Not *B. macranthus minor* Desv. 1853.

An erect, rather densely tufted plant, *glaucous and nearly smooth throughout.* Spikelets 15–18 mm. long; empty glumes unequal, *the lower 1-nerved 3–5 mm. long,* the upper 3-nerved, *5–6 mm. long,* flowering glume 7–8 mm. long. Awn about 2 mm. long. This differs from the species in its glaucous more rigid leaves and smaller, somewhat more coarsely pubescent spikelets.

Type No. 20, collected by V. Havard, slopes of Chisas Mountain, Vieja Mountain, west Texas.

19 γ. BROMUS PORTERI FRONDOSUS n. var. (Fig. 20.)

A slender, weak, erect or ascending, somewhat tufted perennial, about 6–9 dm. high. Culm smooth, leafy. Sheaths smooth; ligule about 1 mm. long, truncate and irregularly dentate; *blades linear, weak,* mostly 1–2 dm. long and 3–4 mm. wide, *smooth throughout.* Panicle 1–2 dm. long, *very weak and drooping;* lower branches 2–4. Spikelets 2–2.5 cm. long, 7-11-flowered, oblong-lanceolate in flower, pale green and drooping; empty glumes *3-nerved, smooth,* mostly acute,

lower 5–6 mm. long, upper 6–7 mm. long, slightly broader; flowering glume subacute, *9–11 mm. long, softly pubescent over the back*, 5–7-nerved, only 3 nerves very distinct, hyaline at the apex and emarginate, awn 2–3 mm. long; palea puberulent, nearly equaling its glume.

Type collected by J. G. Smith at Mangos, New Mexico, August 19, 1897.

SPECIMENS EXAMINED.—*New Mexico:* Mangos Canyon (J. G. Smith, Sept. 21, 1896); (O. Metcalfe, Sept. 20, 1897); Saddle Rock Canyon, Grant County, alt. 2,170 meters (J. G. Smith, Sept. 24, 1896).

Base of San Luis Mountains, International Boundary Collection (E. A. Mearns 2146).

FIG. 20.—*Bromus porteri frondosus:* a, empty glumes and two florets; b, dorsal view of a flowering glume.

This plant, whose favorite habitat seems to be among cliffs in canyons, may prove on further field study to be found worthy of specific rank. The herbarium specimens differ from the species in their very weak, leafy culms, rather narrower and less densely flowered spikelets with the empty glumes smooth.

20. BROMUS PACIFICUS n. sp. (Fig. 21.)

A stout, nearly erect perennial 10–15 dm. high. Culm leafy, pubescent at the nodes. Sheaths mostly sparsely retrorsely-pilose; *ligule 3–4 mm. long*, rounded above, somewhat lacerate dentate; *blades broadly linear-lanceolate, 2–3.5 dm. long, 8–11 mm. broad, sparsely coarse-pilose above, scabrous beneath. Panicle rather large, dense, drooping;* lower branches secund, 3–5. *Spikelets 2–2.5 cm. long, 5–6 mm. wide,* 7–11-flowered, *coarsely pubescent throughout;* empty glumes acute, the lower rather narrow, 1-nerved or rarely with two short faint lateral nerves, 6–7 mm. long, the upper broader, *3–5-nerved, mostly inequilateral at the apex and mucronate, 8–9 mm. long;* flowering glume inconspicuously 7-nerved, broadly lanceolate, subobtuse, emarginate, 11–12 mm. long, *pubescence somewhat denser and somewhat pilose on the lower margins and base, with a straight awn 4–6 mm. long;* palea about equaling its glume.

Type No. 1703, collected by Scribner & Shear, in moist thickets near the seashore south of Seaside, Oregon.

General distribution: Along the coast from Oregon to Alaska.

SPECIMENS EXAMINED.—*Oregon:* Seaside (Scribner & Shear 1711). *Vancouver Island:* (J. Macoun 93). *Alaska:* Prince of Wales Island (W. G. Wright 1595).

This species appears nearly related to *B. richardsoni*, but is much more robust, with rather denser panicle and coarser pubescence which covers the empty glumes as well as the flowering glumes. It appears to be the same as the *B. purgans* of Grisebach in Ledebour's "Flora Rossica."

21. BROMUS PURGANS L. Sp. Pl. **1**:76. 1753. *Bromus ciliatus purgans* A. Gray, Man. Bot. 600. 1848. (Fig. 22.)

Bromus steudelii Frank in Steud. Nom. Bot. ed. 2. **1**:229. 1840. nom. nud.

A rather stout perennial, 7–14 dm. high. Culm erect, smooth or pubescent at the nodes. Sheaths usually coarsely retrorse-pilose; ligule 1–2 mm. long, rather firm, truncate; blades broadly linear-lanceolate, 15–30 cm. long, 5–15 mm. broad, somewhat auricled at the base, short-pilose on the nerves above or smooth, scabrous or smooth beneath. Panicle large, lax, nodding, mostly 15–25 cm. long; lower branches 2–4, long, slender, flexuous. Spikelets mostly 7–11 flowered (Linnæus says "8 ad 14"), 2–2.5 cm. long, terete-acuminate at first, becoming oblong-lanceolate in outline and somewhat flattened; empty glumes narrow, acuminate, *sparsely covered with short pubescence;* the lower *1-nerved, 5–7 mm. long;* the upper broader, 3-nerved, *7–9 mm. long;* flowering glume lanceolate, acute, or sub-acute; 5-nerved, or sometimes with two more faint nerves when mature, *10–12 mm. long, with rather short sparse pubescence over the back,* emarginate or shortly bidentate at the apex; awn straight, slender, *4–6 mm. long;* palea nearly equaling its glume, rachilla slender, pubescent, 2–3 mm. long.

FIG. 21.—*Bromus pacificus:* *a*, empty glumes with two florets; *b*, dorsal view of the flowering glume.

Type collected by Kalm in Canada.

General distribution; New England to Florida, west to northeastern Wyoming, and south to Texas.

SPECIMENS EXAMINED.—*Connecticut:* Bridgeport (E. H. Eames). *New York:* Ithaca (F. V. Coville); Little Falls (G. R. Vasey). *New Jersey:* Stockholm (Wm. M. Vansickle). *Pennsylvania:* Huntingdon County (T. C. Porter); Easton (T. C. Porter); Philadelphia (C. E. Smith 39; F. Lamson-Scribner). *Delaware:* Wilmington (A. Commons 79, 130). *Maryland:* Baltimore (K. A. Taylor 11802). *District of Columbia:* Washington (F. Blanchard); Chain Bridge (Conant & Vasey).

North Carolina: Biltmore (Biltmore Herbarium 128a). *Georgia:* Rome (Dr. Chapman). *Tennessee:* Knoxville (A. Ruth 30); Franklin County (H. Eggert 28). *Kentucky:* Big Black Mountain (T. H. Kearney jr. 276). *Ohio:* Cincinnati (C. G. Lloyd 3515). *Illinois:* Chicago (H. N. Babcock); Mount Carmel (J. Schrenck). *Michigan:* Rochester (O. A. Farwell 563). *Iowa:* Lebanon (C. R. Ball and A. F. Sample 26); Ames (C. R. Ball 123); Fayette County (B. Fink 290, 629); Decatur County (T. J. and M. F. L. Fitzpatrick 12). *Minnesota:* Duluth (G. Vasey). *Wyoming:* Sundance (T. A. Williams 2596). *Nebraska:* Julian (C. L. Elmore 135); near Mullen (P. A. Rydberg 1775). *Missouri:* Independence (B. F. Bush 812); Courtney (B. F. Bush 594). St. Louis (H. Eggert). *Arkansas:* (F. L. Harvey 9). *Indian Territory:* Between Fort Cobb and Fort Arbuckle (Dr. E. Palmer 407).

FIG. 22.—*Bromus purgans:* *a*, lower portion of a spikelet; *b*, dorsal view of a flowering glume.

This species has been the cause of much confusion, and has been very differently interpreted by different authors. Some, including Vahl, Hooker fil., Grisebach, and Fournier, apparently accepting Linnæus's doubtful reference to Feuillée's plate of *B. catharticus* as the true *B. purgans*, have referred various forms of the subgenus *Ceratochloa* to it. Others, as Torrey and Hooker, have referred *B. kalmii* and related forms to it, while Dr. Gray seems to have been the first to apply the name to the plant described by Linnæus, whose description is so complete as to leave little doubt as to the plant he had in hand. The species shows occasional connecting forms with *B. ciliatus*. It is also very closely related to *B. ramosus* of Europe. In the West and North it appears to merge into *B. richardsoni*. It is distinguished from *B. kalmii*, another near relative, by its longer and narrower empty glumes and the shorter and sparser pubescence of the flowering glumes, as well as by its larger panicle and broader leaves.

A specimen in the Columbian University herbarium from Meisner's Herbarium, collected by Frank near Cincinnati, and labeled "*Bromus steudelii* Frank n. sp.?" is merely a form of this species with a somewhat smaller panicle than usual.

21*a*. BROMUS PURGANS LATIGLUMIS (Scribn.) n. comb. *Bromus ciliatus latiglumis* Scribn. in herb. *Bromus altissimus* Pursh, Fl. Am. Sept. **2**: 728. 1814. Not Gilib. 1792. *Bromus ciliatus porteri* Rydb. Contr. Nat. Herb. **3**: 193. 1895.

Culms very leafy, sheaths usually much overlapping and *furnished with a rather conspicuous pilose-pubescent ring at the summit;* blades rather broadly auricled at the base. Spikelets and flowering glumes *rather broader than in the species.* The pubescence at the base of the flowering glume is slightly denser than elsewhere. In other respects like the species.

Type No. 222, collected by L. H. Pammel, Dakota City, Iowa.

General distribution about the same as for the species, but apparently reaching its greatest development in numbers west of the Mississippi.

SPECIMENS EXAMINED.—*Connecticut:* South Glastonbury (Frances Wilson 124). *New York:* Oxford (F. V. Coville). *Pennsylvania:* Easton (T. C. Porter). *Minnesota:* Forest Mills (C. A. Ballard). *South Dakota:* Redfield (David Griffiths 74); Big Stone (Mr. & Mrs. T. A. Williams; James River, Brown County (David Griffiths 784); Canning (T. A. Williams). *Montana:* Smith River (F. Lamson-Scribner 77). *Nebraska:* near Thedford (P. A. Rydberg 1775—this number is the one on which Rydberg founded the new combination cited above. In character of spikelets and in the rather narrower leaves than usual it approaches *B. porteri*, but in other respects it is this variety; Holt County (F. Clements 2824). *Iowa:* Forest City (B. Shimek 62); Ames (C. R. Ball 4); Jackson County (B. Shimek 34); Dakota City (L. H. Pammel 222). *Missouri:* (H. Eggert); Jefferson County (H. Eggert 606); Allenton (G. W. Letterman 14).

This form connects the species with *B. richardsoni* and *B. porteri*, the more numerous leaves, the overlapping sheaths, and larger panicle separating it from the latter. The overlapping sheaths and more equally distributed pubescence of the flowering glume distinguishes it from the former. The citation of *B. altissimus* Pursh as a synonym is based upon the examination of specimens in the herbarium of the Philadelphia Academy marked "Herb. Pursh." The specimens agree perfectly with Pursh's description and are apparently authentic.

21β. BROMUS PURGANS ? TEXENSIS n. var.

A slender plant, somewhat geniculate at the base and 3–4 dm. high. Sheaths short pilose-pubescent; ligule 1–1.5 mm. long, laciniate; blades linear, *pubescent throughout*, about 6–10 cm. long. Panicle small, somewhat nodding, with only 3–5 spikelets in the specimen at hand. Spikelets terete at first, then lanceolate and somewhat laterally contracted; empty glumes acuminate, scabrous, the lower 1-nerved, 7 mm. long, the upper inequilateral and mucronate at the apex, 9–10 mm. long; flowering glume 7-nerved, 10 mm. long, *sparsely and coarsely scabrous*, very short dentate at the apex; awn straight, 6–7 mm. long; palea equaling its glume, *keels finely serrate.*

Type No. 230, collected by G. Jermy, Bexar County, Texas.

This is the only specimen of this form we have seen. More material is necessary to determine definitely its status and relationships. It may prove a good species.

21γ. BROMUS PURGANS INCANUS n. var.

This is very near *B. purgans latiglumis*, differing from it in having the sheaths densely soft pilose-pubescent. It also passes into *B. porteri lanatipes* in the southwest. It is generally separated from that by its broader leaves and narrower empty glumes, which are like the flowering glumes sparsely pubescent.

Type No. 3, collected by J. Wolf, Canton, Illinois.

General distribution apparently about the same as for the species.

SPECIMENS EXAMINED.—*Pennsylvania:* Easton (T. C. Porter). *District of Columbia:* High Island (F. L. Scribner). *Ohio:* Pittsfield (A. E. Ricksecker). *Iowa:* Fayette County (B. Fink, 414). *South Dakota:* Union County (E. J. Wallace). *Texas:* Chenates (G. C. Nealley), poor and not typical.

22. BROMUS ORCUTTIANUS Vas. Bot. Gaz. **10**: 223. 1885. (Fig. 23.)

A rather stout, erect, perennial 8–12 dm. high. Culm leafy below, mostly puberulent at and just below the nodes. Sheaths *usually glabrous;* ligule 1–2 mm. long, subtruncate; blades *broadly linear-lanceolate, rather coarse, smooth throughout,* 10–20 cm. long, 5–7 mm. broad. *Panicle narrow-pyramidal, erect, or nearly so,* 10–15 cm. long, 5–8 cm. broad at the base when spread, branches few, *widely divaricate in fruit and rather rigid.* Spikelets about 2–2.5 cm. long, 2–3 mm. broad, on short, stout pedicles, terete-acuminate, 5–9 flowered; florets at maturity rather distant on a slender zigzag rachilla, separating and falling easily at maturity; empty glumes narrow, smooth or scabrous, the lower acute, 6–8 mm. long, 1-nerved, or sometimes with 2 short, faint lateral nerves, the upper broader, subobtuse, 3-nerved, 8–10 mm. long; flowering glume 10–12 mm. long, narrow, obtuse, *scabrous to scabrous-pubescent over the back,* faintly 5–7-nerved, with a hyaline, slightly emarginate apex; awn rather stout, about 5–7 mm. long; palea nearly equaling its glume; rachilla slender, puberulent, joints about 4 mm. long.

FIG. 23.—*Bromus orcuttianus: a,* empty glumes with a floret; *b,* dorsal view of a flowering glume.

Type in the Herbarium U. S. Department of Agriculture, collected by C. R. Orcutt in the mountains near San Diego, Cal., No. E.

General distribution: Southern California to Washington, chiefly on rather dry open mountain sides and in dry evergreen forests.

SPECIMENS EXAMINED.—*California:* Open woods, Truckee River (C. F. Sonne 21); Southern California (Dr. E. Palmer 233); Mariposa (J. W. Congdon); Pioneer (Geo. Hansen 1835); Kaweah River Valley (Coville and Funston 1346); San Jacinto Mountains (H. M. Hall 7861); Forest Dale (J. B. Davy). *Oregon:* Ashland Butte (T. Howell 253); Gayhart Butte (Coville and Leiberg 277). *Washington:* Mount Adams (W. N. Suksdorf 120); Klickitat River near Mount Paddo (Mount Adams) (W. N. Suksdorf 172).

22a. BROMUS ORCUTTIANUS GRANDIS n. var.

A stout, erect perennial 14–15 dm. high, very leafy below. Sheaths, leaves, and culm pubescent throughout. Panicle about 2 dm. long and nearly as broad at base at maturity when the branches are spread more or less horizontally. Spikelets pubescent throughout. Its distinguishing characters are its size and pubescence. In other respects the plant is like the species.

Type No. 472, collected by C. R. Orcutt at La Maite, San Diego, California. The only specimen seen.

23. BROMUS VULGARIS (Hook) n. comb. (Fig. 24.)

B. purgans vulgaris Hook. Fl. Bor. Am. **2** : 252. 1840. *B. debilis* Nutt. in Herb. Acad. Nat. Sci. Phil. *B. ciliatus pauciflorus* Vasey in Beal Grass. N. A. **2** : 619. 1896. Not Schum. nor Willd. *B. ciliatus ligulatus* Vas. in Macoun Cat. Can. Pl. **4** : 238. 1888. Nomen nudum.

FIG. 24.—*Bromus vulgaris: a*, showing empty glumes : *b*, partial ventral view of a floret showing the palet and a joint of the rachilla.

A slender, erect perennial 8 to 11 dm. high, with narrow, pale green, *sparingly pilose leaves and few-flowered, nodding panicle*, 8 to 12 cm. long. Culms somewhat pubescent, at least below the nodes, nodes bearded, the short hairs directed downward. Sheaths *pilose, lower ones which are usually purplish, quite densely so, with spreading or reflexed hairs;* ligule *membranous or subhyaline, truncate, lacerate, 3–5 mm. long;* blades 15–25 cm. long, 5–9 mm. wide, thinly pilose above, glabrous or sparsely pilose beneath, sparingly scabrous on the margins and on the nerves below. Spikelets about 22–28 mm. long, including awns, 3–4 mm. wide; pedicels somewhat enlarged just below the spikelet and pubescent; empty glumes *somewhat sparsely covered with a short, coarse pubescence*, lower glume narrow-lanceolate, very acute, 5–8 mm. long, 1-nerved; upper glume *3-nerved, much broader and longer than the first, obtuse or subacute and often bifid at the apex, the midnerve excurrent as a short awn*, scabrous on the back, the nerves usually purplish; flowering glume about 8–10 mm. long, *sparsely pubescent over the back, subciliate near the margins*, 5-nerved, the 3 nerves much more prominent than the intermediate

ones; apex entire or shortly 2-toothed; awns *slender, 6–9 mm. long.* Joints of the rachilla 2–3 mm. long, pubescent; palea nearly or quite equaling its glume, ciliate on the keels and scantily pubescent between them.

Type: Hooker l. c. refers several collections made by Richardson, Douglas, and Scouler to this species. Through the kindness of the director of the Kew Gardens we have received a spikelet from the specimens collected by Dr. Scouler on the Columbia which proves to be the same as the synonyms given.

General distribution: California north to Vancouver Island, east to Montana and the Blue Mountains of Oregon. The typical form seems to be most frequent in the Blue Mountains.

Specimens examined.—*California:* Santa Cruz (M. E. Jones); Marin Co. (E. Palmer 2043); (C. L. Anderson 66;) (H. Bolander 4753.) *Oregon:* (W. C. Cusick 1061, 2061;) (T. Howell 80, 205;) banks Santiam (M. Craig); Portland (T. Howell); McMinnville (C. L. Shear 1652); Lake Wallowa (C. L. Shear 1747); Blue Mountains (C. L. Shear 1690, 1667). *Washington:* Klickitat River (W. N. Suksdorf 177); West Klickitat Co. (W. N. Suksdorf 175); Upper Valley Nesqually (O. D. Allen 41); Blue Mountains (C. V. Piper 2564, 2563; Lake & Hull 2079); (Sandberg & Leiberg 449;) (L. F. Henderson 2145;) Tacoma (A. B. Leckenby). *Idaho:* Latah Co. (C. V. Piper 1740); Moscow Mountains (L. F. Henderson); Lake Coeur d'Alene (Sandberg, Heller & McDougal 582); Farmington (Sandberg, Heller & McDougal 523); Nez Perces Co. (A. A. & E. G. Heller 3423). *Montana:* Bozeman (P. A. Rydberg 2227); Sour Dough Canyon (J. W. Blankinship). *British Columbia:* Deer Park, Lower Arrow Lake (J. Macoun 17).

This plant has most frequently been referred to *B. ciliatus* heretofore, but is easily separated from that species by its smaller panicle, longer awn, and long ligule, and also by the distribution of the pubescence on the flowering glume. It is quite variable in some respects and seems to pass through its various forms into *B. lævipes.*

23α. BROMUS VULGARIS EXIMIUS n. var. *Bromus ciliatus glaberrimus* Suksdorf in herb. Not *B. glaberrimus* Koch, Linnæa, **21**: 420. 1848.

A more erect and robust plant than the type, leaves broader, in the type 1 cm. broad, leaves, sheaths, and culms glabrous as is also the flowering glume except on the margin and midnerve near the base where it is scantily pubescent.

Type No. 1791, collected by C. L. Shear on moist, open mountain side 4 miles above Wallowa Lake, Oregon.

General distribution: Oregon and Washington.

Specimens examined.—*Oregon:* near Wallowa Lake (C. L. Shear 1787, 1799). *Washington:* Skamania Co. (W. N. Suksdorf 2335). This number was the type of Suksdorf's variety cited above. Yakima region (F. Tweedy, July, 1882).

23β. BROMUS VULGARIS ROBUSTUS n. var.

A tall leafy form sometimes reaching 15–18 dm. high; leaves and sheaths sparsely pilose-pubescent; the panicle larger than in the species and having the flowering glumes pubescent on the margin and keel at the base, as in *B. vulgaris eximius,* from which it differs chiefly in the pilose-pubescent leaves and sheaths and rather larger panicle.

Type No. 1710, collected by Scribner and Shear in moist thickets near the seashore, Seaside, Oregon.

General distribution: Oregon to Vancouver Island along the coast; also from Idaho.

Specimens examined.—*Oregon:* Seaside (Scribner & Shear 1707, 1710); McMinnville (C. L. Shear 1653). *Idaho:* Weisners Peak (Sandberg, Heller & McDougal 599). *Washington:* Base of Mount Adams (W. N. Suksdorf 176); near Montesano (A. A. & E. G. Heller 3999). *Vancouver Island:* (J. Macoun 176) not typical.

24. BROMUS LÆVIPES n. sp. (Fig. 25.)

A perennial, *spreading somewhat by rootstocks*, with an erect or somewhat geniculate culm about 7-10 cm. tall, puberulent just below the nodes. Sheaths *glabrous;* ligule *3-4 mm. long*, truncate, entire or somewhat lacerate-dentate; blades linear-lanceolate, *glabrous or slightly scabrous*, about 15-20 cm. long and 4-7 mm. broad. Panicle broad, lax, drooping, about 15-20 cm. long, lower branches 2-4. Spikelets drooping, narrow, terete, acuminate at first, 5-9-flowered, 2.5-3.5 cm. long; empty glumes smooth, the lower acute, 3-nerved, 6-8 mm. long; the upper 5-nerved, broader, 9-11 mm. long; flowering glume obtuse, 7-nerved, *12-15 mm. long, densely ciliate-pubescent on the margin nearly to the apex and also on the back at the base;* apex hyaline, emarginate, usually brownish yellow; awn straight, 3-4 or rarely 5 mm. long; palea about 2 mm. shorter than its glume.

Type No. 178, collected by W. N. Suksdorf on the Columbia River, West Klickitat Co., Washington.

General distribution: Mostly in the Coast Range and Cascade Mountains, California, north to Washington.

SPECIMENS EXAMINED.—*California:* Hood's Peak (Bioletti 112); Black Mt. (C. Rutter 1); San Jose (Miss Bush); Borax Lake (J. Torrey 574—a poor specimen, somewhat doubtful); Pitt River, Shasta Co. (H. E. Brown 279); Head of Russian River (J. W. Blankinship 41); Agricultural Station, Amador Co. (Geo. Hansen 610); no locality (G. R. Vasey). *Oregon:* Grant's Pass (T. Howell 250).

FIG. 25.—*Bromus lævipes: a*, empty glumes with two florets; *b*. dorsal view of a flowering glume.

This species is closely related to *B. vulgaris*, *B. orcuttianus* and *B. richardsoni pallidus*. From the first it is distinguished by its smooth leaves and sheaths and much stouter habit, as well as broader spikelets and denser pubescence of the flowering glume. From the second it differs in the larger drooping panicle and different distribution of pubescence on the flowering glume. It appears closest to the third, *B. richardsoni pallidus*, into which it probably intergrades. It differs in its typical form from that in its much more robust habit and more pubescent flowering glumes; also in its geniculate base and the production of a rootstock.

B. *Panicle narrow, erect or nearly so, spikelets usually larger than in A, and the pubescence on the flowering not evenly distributed.*

25. BROMUS SUKSDORFII Vas. Bot. Gaz. **10**: 223. 1885. (Fig. 26.)

An erect, coarse, tufted, leafy perennial, 6–10 dm. high. Culm smooth or puberulent just below the nodes. Sheaths smooth; ligule about 1 mm. long, *subcoriaceous*, truncate, dentate; *blades mostly 5–6, broadly linear-lanceolate, rather abruptly acuminate, 1–2 dm. long, 8–11 mm. broad, firm and smooth.* Panicle narrow, erect, *rather dense*, mostly 8–13 cm. long, lower branches 2–5, *longest 2–4 cm. long, erect or ascending.* Spikelets 5–9-flowered, 2–3 cm. long, terete at first, becoming somewhat lanceolate at flowering; pedicels *shorter than the spikelets;* empty glumes glabrous or scabrous on the nerves, the lower lanceolate-acuminate, 1-nerved or sometimes with a short faint lateral nerve on each side, 8–10 mm. long, the upper broader, subacute, 3-nerved, 10–12 mm. long; flowering glume oblong-lanceolate, subacute, *12–14 mm. long* with 3 prominent nerves and frequently 2 other very faint ones on each side, *appressed-pubescent from the lateral nerves to the margins and on the midnerve about halfway up the back,* other portions smooth or scabrous, emarginate at the apex; awn 2–4 mm. long; *palea little more than three-fourths the length of its glume.*

FIG. 26.—*Bromus suksdorfii: a,* empty glumes with two florets; *b,* dorsal view of a flowering glume.

Type No. 74, collected by W. N. Suksdorf "in loose soil on dry mountain sides," Mt. Adams, Washington.

General distribution: Mountains of Oregon and Washington.

SPECIMENS EXAMINED.—*Oregon:* Crater Lake (Coville & Leiberg 423); Powder River Mt. (C. V. Piper 2523); Ashland Butte (T. Howell 249); (W. C. Cusick 1075).

This species is closely related to *B. pumpellianus*, but differs in lacking the creeping rootstock and in having a denser panicle, longer flowering glume with shorter pubescence and shorter palea. The spikelets are also narrower in flower and greenish straw color.

26. BROMUS ERECTUS Huds. Fl. Angl. 39. 1762. *Bromus macounii* Vas. Bul. Torr. Bot. Club, **15**: 48. 1888. (Fig. 27.)

A cæspitose perennial with narrow leaves and an erect subsimple panicle. Culms about 6–9 dm. high, erect, glabrous. Sheaths sparingly pilose or nearly glabrous; ligule about 1.5 mm. long; blades somewhat rigid, narrowly linear, sparingly

pubescent or somewhat ciliate, *the radical conduplicate*, those of the stem somewhat broader, about 1–2 dm. long. Panicle about 1–2 dm. long, narrow, pyramidal, branches erect or ascending. Spikelets fusiform-cylindric before flowering, afterwards oblong-lanceolate and somewhat laterally compressed, 5–10-flowered, sometimes purplish; empty glumes acuminate, usually scabrous on the nerves; the lower 1-nerved, 6–8 mm. long; the upper 3-nerved, 8–10 mm. long; flowering glume 10–12 mm. long, 5-nerved, oblong-lanceolate, acuminate, shortly bidentate with narrow scarious margins and apex *evenly scabrous-pubescent on the back;* awn straight, slender, 5–6 mm. long. An adventive species from Europe.

SPECIMENS EXAMINED—*Ontario:* Kingston (J. Fowler in 1895). *Vermont:* (C. G. Pringle in 1877).

This species is reported in Britton & Brown. Ill. Fl., as being introduced in waste places about New York. The specimen collected by J. Macoun, No. 76, Vancouver Island, and named *B. macounii* by Vasey, seems to us a mere form of this species, differing only in its somewhat narrower and more rigid panicle. This species is nearly related to *B. pumpellianus.*

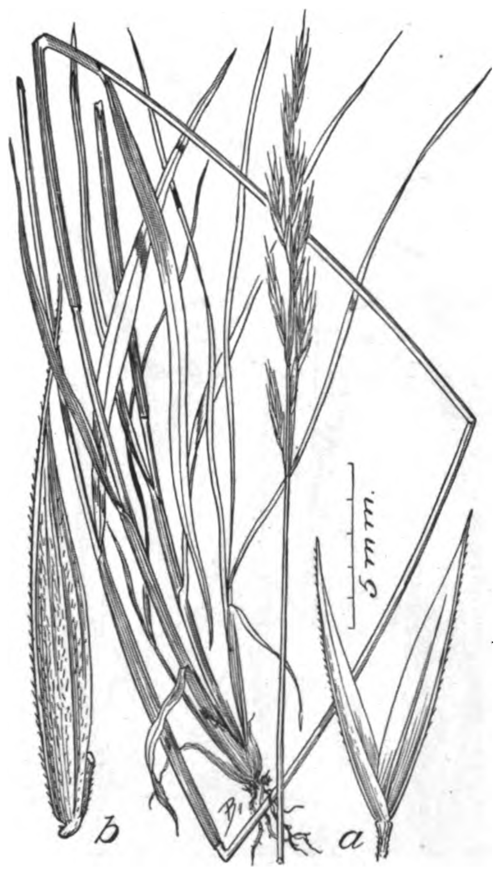


FIG. 27.—*Bromus erectus: a*, empty glumes; *b*, lateral view of the flowering glume with a joint of the rachilla.

27. BROMUS INERMIS Leyss. Fl. Hal. 16. 1761. *Schedonorus inermis* Beauv. Agrost. 99. 1812. (Fig. 28.)

An erect, smooth perennial with a creeping rootstock and erect, *broadly pyramidal or subcorymbose panicle.* Culm rather stout, smooth, about 5–9 dm. high. Sheaths smooth; ligule 1.5–2 mm. long, subtruncate, somewhat lacerate; blades linear-lanceolate, flat, smooth, or minutely scabrous, about 1.5–2.5 dm. long and about 5–10 mm. broad. Panicle rather dense, somewhat diffuse, 10–20 cm. long. Spikelets erect or somewhat drooping, *narrow, terete, about 2–2.5 cm. long and 4–5 mm. wide after flowering;* empty glumes smooth, the lower narrow, acute, 1-nerved, 4–5 mm. long, the upper subacuminate, 3-nerved, about 6–8 mm. long; flowering glume obtuse, emarginate, 5-nerved, *about 9–12 mm. long, typically glabrous,* but sometimes ciliate-pubescent on the lower half of the margins and the midrib, muticous or with an awn sometimes reaching 3 mm. long; palea equaling the glume.

General distribution: This species, which has been introduced from Europe under the name of smooth or Hungarian brome-grass, is being grown in many places throughout the semiarid regions of the West, where it is to be met with as an escape from cultivation.

It is very closely related to *Bromus pumpellianus*, but has narrower panicles and spikelets, also smoother glumes.

28. BROMUS PUMPELLIANUS Scribn. Bul. Torr. Bot. Club **15**: 9. Jan. 1888. *Bromus purgans purpurascens* Hook. Fl. Bor. Am. **2**: 252. 1840. Not *B. purpurascens* Del. 1813. *Bromus macounii* Vas. p. p. Bul. Torr. Bot. Club, **15**: 48. 1888. (Fig. 29.)

FIG. 28.—*Bromus inermis*: *a*, a spikelet; *c*, ventral view of a floret, showing the palea and a joint of the rachilla.

A stout, erect perennial, 6–12 dm. high, with creeping rootstocks. Culms smooth or pubescent at the nodes. Sheaths smooth or sparsely pilose-pubescent; ligule firm, truncate, rarely exceeding 1 mm. long; blades broadly linear-lanceolate, 5–10 mm. wide, 1–2 mm. long, mostly smooth below and scabrous or somewhat pubescent above, somewhat auriculate at base, point frequently involute and rigid when dry. Panicle *rather narrow, erect*, 10–20 cm. long, mostly 10–15 cm.; branches short, erect, or ascending. Spikelets mostly 7–11-flowered, 2–3 cm. long, terete-acuminate at first, somewhat laterally compressed at and after flowering, *5–7 mm. wide;* empty glumes smooth and shining, the lower 1-nerved, or rarely with two faint lateral nerves, acuminate, 6–8 mm. long, the upper broader, 7–10 mm. long, 3-nerved; flowering glume broad, ovoid-lanceolate, subacute, 5–7-nerved, 10–12 mm. long, *densely and coarsely ciliate-pubescent on the margin, nearly or quite to the apex and across the back at the base;* apex slightly emarginate; awn mostly 2–3 mm. long, rarely reaching 4–5 mm. long, or occasionally nearly or quite muticous; palea *nearly equaling its glume;* rachilla slender, pilose-pubescent.

Type No. 418, collected by F. Lamson-Scribner in the Belt Mountains, Montana.

General distribution: Colorado to South Dakota north to western Alaska.

SPECIMENS EXAMINED.—*Colorado:* Dillon (C. L. Shear 1068½); Penns Gulch (G. W. Letterman 93); El Paso County (G. W. Letterman 38); Pikes Peak (C. L. Shear 771); Villa Grove (C. L. Shear 885); Breckenridge (C. L. Shear 1082); Veta Pass

(G. Vasey); no locality (John Wolfe 1158); Grizzly Creek (C. F. Baker 14); Como Park (C. L. Shear 1092). *Wyoming:* Sundance (T. A. Williams 2602, D. Griffiths 423); Bear Lodge (T. A. Williams 2629); Inyan Kara Mountain (D. Griffiths 634); Big Horn Mountains (W. H. Forwood). *South Dakota:* Custer (David Griffiths 700); Elk Creek, Black Hills (P. A. Rydberg 1167); Sylvan Lake (D. Griffiths 719, 708). *Montana:* Columbia Falls (R. S. Williams); Gallatin River Canyon (J. W. Blankinship); Black Hawk (P. A. Rydberg 3271); Dry Fork Belt Creek (P. A. Rydberg 3356); Barker (P. A. Rydberg 3362, 3383). *British America:* Rocky Mountains (J. Macoun 14); Fort Ellice (J. Macoun 104). *Alberta:* Near Banff (J. Macoun 23, 30); Benton Trail, Milk River (J. Macoun 13051); Devils Head Lake (J. Macoun 25, 27); Elbow River (J. Macoun 18638); Crow Nest Pass (J. Macoun 18639). *Saskatchewan:* Prince Albert (J. Macoun 13050); Saskatchewan Plains (J. Macoun 78). *British Columbia:* Kicking Horse Lake (J. Macoun 15). *Alaska:* Fort Yukon (O. S. Bates).

FIG. 29. *Bromus pumpellianus:* a, empty glumes with two florets; b, dorsal view of a flowering glume.

This plant is closely related to *B. erectus* and also to *B. inermis*, both of which are only found in this country as introduced or adventive species. Our species, which is rather frequent in the Rocky Mountains from Colorado north, reaches Alaska and probably connects with *B. inermis* in eastern Siberia. Our plants can usually be distinguished from *B. erectus* by their broader spikelets, longer awns, and the coarse ciliate-pubescent margins and bases of the flowering glumes. The leaves of the sterile shoots or innovations of *B. erectus* are narrow and involute and the plant cæspitose. In the case of *B. inermis* the relationship is closer and the separation more difficult. Generally our species has a narrower, denser, more rigidly erect panicle with shorter branches and broader spikelets. The flowering glumes are more coarsely and densely ciliate-pubescent and very rarely muticous. The difficulties of separating these species are likely to be greatly increased in the future by the rapid distribution of the cultivated forms of *B. inermis* in the region occupied by *B. pumpellianus* and also by the probability of hybridization of the two plants. Judging from the description and a single spikelet from the type of Hooker's *B. purgans purpurascens*, collected by Dr. Richardson in the region of Bear Lake, British America, it is the same as our plant.

28α. BROMUS PUMPELLIANUS TWEEDYI Scribn. in Beal, Grass. N. A. **2**: 622. 1896.

This differs from the species in having the leaves and sheaths usually pilose-pubescent throughout and the flowering glumes with coarser, denser, hirsute-pubescence. In other respects like the species.

Type No. 587, collected by Frank Tweedy, Slough Creek, Yellowstone Park.

General distribution apparently the same as for the species.

SPECIMENS EXAMINED.—*Colorado:* (H. N. Patterson 29); (M. E. Jones.) *Wyoming:* Sundance (D. Griffiths 435, 884); Meeteetse Creek (T. A. Williams 2917); Welcome (T. A. Williams 2673, 2682); Bear Lodge (T. A. Williams 2655). *Montana:* Lima (P. A. Rydberg 2309, C. L. Shear 568). *Alaska:* Yukon River (Dawson 92).

FIG. 30. *Bromus unioloides:* *a*, empty glumes; *b*, lateral view of a flowering glume.

28β. BROMUS PUMPELLIANUS MELICOIDES n. var.

This is a form having the sheaths retrorsely pilose-pubescent, especially on the lower half toward the nodes. The pubescence on the margins and of the flowering glume is rather short and scanty, and the awn is entirely wanting or sometimes 1 mm. long.

Type collected by Dr. L. H. Pammel, Beaver Creek Camp, Colorado, July 8, 1896, altitude about 3400 meters. This plant is rather intermediate between *B. pumpellianus* and *B. inermis*, but is apparently an endemic form and belongs rather with the former than the latter. The obtuse glumes, with thin, purple margins, give the plant a strong resemblance to *Melica*, whence the name.

V. CERATOCHLOA (Beauv.) Benth. & Hook.

Spikelet large, strongly compressed, and more or less keeled.

29. BROMUS UNIOLOIDES (Willd.) H. B. K. *Festuca unioloides* Willd. Hort. Berol. **1** : 3. *pl. 3.* 1806. *Bromus unioloides* H. B. K. (?) Nov. Gen. et Sp. Pl. **1**: 151. 1815. *Bromus carthárticus* Vahl. (?) Symb. Bot. **2** : 22. 1791. *Ceratochloa pendula* Schrad. Linnæa, **6** : Litt. 72. 1831. *Ceratochloa schraderi* Kunth, Enum. Pl. **1** : 416. 1833. *Ceratochloa breviaristata* Hook. Fl. Bor. Am. **2** : 253. 1840.

Bromus willdenowii Kunth, Rev. Gram. 1 : 134. 1835. *Ceratochloa submutica* Steud. (?) Syn. Pl. Gram. 321. 1854. (Fig. 30.)

A rather stout annual, with erect or suberect panicle and strongly compressed oblong-lanceolate spikelets. Culms glabrous, about 5–10 dm. high. Sheaths usually pilose-pubescent, sometimes smooth, typically with a tuft of hairs at the base of the ligule; ligule about 3–4 mm. long, somewhat laciniate on the margin; blades linear, scabrous on both sides or sparingly pilose-pubescent. Panicle *usually elongated and narrow pyramidal, 1.5–3.5 dm. long;* lower branches 2–4, short in small forms, to rather long, spreading, or somewhat drooping in the larger ones. Spikelets 2–3.5 cm. long, 5–9 mm. broad, about 7–11-flowered; empty glumes broad, subacute, smooth or slightly scabrous, the lower usually 5-nerved, 7–10 mm. long, the upper usually 7-nerved, 10–13 mm. long; flowering glumes broadly lanceolate, acute, subcoriaceous, subglabrous to coarsely scabrous, slightly bidentate at the apex, about 13–16 mm. long, usually with a short stout awn, rarely exceeding 2 mm. long; *palea between one-half and three-fourths the length of its glume.*

General distribution: Alabama to California and southward. Perhaps introduced throughout most of our range. Occasionally met with in other Southern States.

Type grown at Berlin from seed sent from Carolina.

Specimens examined.—*Alabama:* Montgomery (C. Mohr in 1868); Auburn (Earle & Baker 1502). *Louisiana:* Calhoun (C. R. Ball 76). *Texas:* San Antonio (A. W. Barr 1873); Riddleville (W. S. Ruckman in 1885). *New Mexico:* (A. Fendler 918—an immature plant approaching *B. polyanthus paniculatus*). *Arizona:* Pipe Spring (M. E. Jones 5272i); Tucson (J. W. Toumey 28). *California:* Kern County (A. B. Leckenby in 1896).

Fig. 31.—*Bromus unioloides haenkeanus: a*, empty glumes with two florets; *b*, dorsal view of a flowering glume.

Bromus catharticus Vahl, l. c., judging from the original description, is but a mere form of this species, and were it not for the reference to Feuillée's plate (Jour. Obs. Phys., etc., de l' Amèrique Merid. & Ind. Occ. 1) as representing the plant, we should not hesitate about adopting the name; but after examining a tracing of the plate kindly furnished by Dr. Robinson, we are inclined to think that there is a mistake, either in our interpretation of Vahl's description, or in his reference to Feuillée's plate, as that does not represent our plant. Only an examination of Vahl's type will settle the question conclusively. *Bromus submuticus* Steud l. c., collected at St. Louis, judging from the original description, belongs here. We have been unable thus far to locate the type specimen, so the matter still remains in some doubt.

An examination of a spikelet from the type of *Ceratochloa breviaristata* Hook. proves conclusively that this is a mere short-awned form of *B. unioloides*. It is possible that the locality cited, "on the dry elevated ground of Lewis and Clarkes River and near the sources of the Columbia," may be the result of a confusion of labels. The plant, if found there, must almost certainly have been an adventitious one, which seems to us scarcely probable at that time—1826.

This species has been in cultivation so long that its endemic distribution is difficult or impossible to determine.

29*a*. BROMUS UNIOLOIDES HÆNKEANUS (Presl.) n. comb. *Ceratochloa hænkeana* C. B. Presl in J. S. Presl, Reliq. Hænk. **1**: 285. 1828. (Fig. 31.)

An annual or biennial plant differing from the species in its smaller size, being about 1.5–5 dm. high, and narrow, erect, subracemose panicle 5–10 cm. long, with somewhat smaller spikelets. The leaves are narrow, linear, pilose, pubescent, both sides and sheaths retrorsely pilose. Type collected "in Cordilleris chilensibus, inque montanis Peruviæ." General distribution: Florida to southern California.

SPECIMENS EXAMINED.—*Florida:* Madison (R. Combs 247—a form with somewhat pubescent glumes). *Alabama:* Mobile (T. H. Kearney 16). *Texas:* Bexar County (G. Jermy 229); Hempstead (E. Hall 792); (J. Reverchon 119); Dallas (J. Reverchon 1105); Fort Clark (E. A. Mearns 1273); Corpus Christi (A. A. Heller 1497). *California:* Mentone (J. B. Leiberg 3296). Our specimens are like specimens from the type collection in the Bernhardi herbarium at the St. Louis Botanical Gardens (cf. Rept. Mo. Bot. Gard. **10:** *pl. 54. f. l.* 1898) except that the sheaths are more pilose.

FIG. 32.—*Bromus subvelutinus: a*, empty glumes with two florets; *b*, dorsal view of a flowering glume.

30. BROMUS SUBVELUTINUS n. sp. (Fig. 32.)

An erect, tufted perennial. Culm somewhat puberulent above, about 2.5–5 dm. high, *densely clothed at the base with the old sheaths*. Sheaths *canescent;* ligule about 1 mm. long, truncate, laciniate; blades *narrow, linear, rather rigid, becoming involute, canescent and also pilose with spreading hairs*, those of the culm 4–10 cm. long, those of the innovations longer. Panicle about 5–10 cm. long, narrow, erect, simple, sometimes bearing but a single spikelet, or the lower branches in pairs and about 1–3 cm. long. Spikelets 5–7 flowered, 2–3 cm. long, laterally compressed, becom-

ing rather turgid at maturity; empty glumes subobtuse, puberulent, the lower 3–5-nerved, 8–10 mm. long, the upper 7-nerved, 10–12 mm. long; flowering glume *appressed-puberulent*, indistinctly 7-nerved, 12–15 mm. long, with two short, rather obtuse, hyaline teeth and a *stout awn 3–4 mm. long;* palea short pectinate-ciliate on the keels, about 3 mm. shorter than its glume.

Type No. 249, S. M. Tracy, collected at Reno, Nevada, in 1887.

Distribution: Nevada and California.

SPECIMENS EXAMINED.—Nevada: l. c. *California:* Grassy mountain slope, Fort Tejon (S. B. Parish No. 1995).

This plant is most closely related to *B. marginatus* from which it is distinguished chiefly by the narrow, rigid, involute leaves, canescent leaves and sheaths, and somewhat cæspitose habit. It seems to be peculiar to arid regions.

31. BROMUS MARGINATUS Nees in Steud. Syn. Pl. Gram. 322. 1854. *Bromus breviaristatus* Buckl. and most auct. amer. Not *Ceratochloa breviaristata* Hook. *Bromus pauciflorus* Nutt. in Herb. Acad. Nat. Sci. Phil. (Fig. 33.)

An erect, tufted, rather stout, short-lived perennial. Culm 6–12 dm. high, mostly puberulent or pubescent. Sheaths *pilose-pubescent;* ligule 3–3.5 mm. long, subrotund, laciniate; blades broad, linear-lanceolate, *somewhat sparsely pilose-pubescent throughout,* rather rough and coarse, 1.5–2.5 dm. long, 6–12 mm. wide. Panicle erect, rather narrow, mostly 1–2 dm. long; *lower branches 2–4, erect, or somewhat spreading in flower, unequal, lowest rarely more than 7 cm. long and bearing 2 spikelets.* Spikelets 2.5–4 cm. long, 5–7 mm. wide, oblong-ovoid to oblong-lanceolate, laterally compressed, somewhat turgid at maturity, mostly 7–9-flowered, erect or ascending, the uppermost subsessile; empty glumes, *rather broad, scabrous to scabrous-pubescent;* the lower subacute, 3–5-nerved, mostly 7–9 mm. long; the upper broader, obtuse, 9–11 mm. long, 5–7-nerved, the lateral nerves broad; flowering glume, *subcoriaceous, coarsely pubescent,* ovate-lanceolate, acute, 11–14 mm. long, mostly 7-nerved, with two very short hyaline, *subacute teeth at the apex and a rather stout straight awn 4–7 mm. long;* palea ciliate-pectinate on the keels, almost or quite equaling its glume.

FIG. 33.—*Bromus marginatus:* *a*, empty glumes with three florets; *b*, dorsal view of a flowering glume.

Type collected by Douglas "on the Columbia River, St. Louis." The reference to St. Louis is evidently either an error or else refers to some locality on the Columbia not at present recognized in our atlases.

General distribution: Arizona and Colorado to Alberta and west to the Pacific.

SPECIMENS EXAMINED.—*Arizona:* (Dr. E. Palmer in 1869; 535 in 1876); Grand Canyon, (D. T. McDougal 181); Tucson (J. W. Toumey 752½). *Colorado:* (C. S. Crandall 523). *Wyoming:* Sundance (T. A. Williams 2611, 2612, and Griffiths 434, 911); Meeteetse Creek (T. A. Williams 2904); Bear Lodge (Williams 2655a); Little Laramie River (Williams 2322, 2230, and Aven Nelson 3333); Powder River (T. A. Williams 2799); Spring Creek (T. A. Williams 2813½, J. N. Rose 698); Sherman (G. W. Letterman 81); Parkman (Aven Nelson 2457); Sheridan (L. H. Pammel 1897); Hewlett (D. Griffiths 932); Beulah (Griffiths 970); Little Missouri Buttes (D. Griffiths 585); Medicine Bow River (A. Nelson 4073). *Yellowstone National Park:* Soda Butte (F. Tweedy 586). *Montana:* Bozeman (C. L. Shear 449, P. A. Rydberg 3006, 3000); Lima (C. L. Shear 569, P. A. Rydberg 2314); Mystic Lake (P. A. Rydberg 2247); Boulder Creek (F. Lamson-Scribner 4); Castle (P. A. Rydberg 3252, 3259); Spanish Creek Basin (P. A. Rydberg 3109, T. A. Williams 2007, 2039); Dry Fork Belt Creek (P. A. Rydberg 3355); Deer Lodge (P. A. Rydberg 2119, C. L. Shear 378); Manhattan (C. L. Shear 415); Columbia Falls (R. S. Williams 604). *Alberta:* St. Mary's River (J. Macoun 13038). *British Columbia:* Lower Frazer River, 49° north latitude (Dr. Lyall in 1859). *Idaho:* Nez Perces County (Sandberg, Heller, and McDougal 331); Hatwai Creek (L. F. Henderson 2828). *Washington:* (Sandberg & Leiberg 450); Pullman County (A. D. E. Elmer 253); Yakima (A. B. Leckenby 1898); Blue Mountains (C. V. Piper 2565); Columbia River, Klickitat County (W. N. Suksdorf 174); Waitsburg (R. M. Horner 568); Walla Walla (C. L. Shear 1593). *Oregon:* Elgin (C. L. Shear 1734); east side Harney Valley (J. B. Leiberg 2370); above Wallowa Lake (C. L. Shear 1803); Gearhart (C. L. Shear 1695, W. C. Cusick 650a). *Nevada:* Diamond Mountains (S. Watson 1327); Virginia Mountains (S. Watson 1326); Reno (S. M. Tracy 224). *California:* (J. G. Lemmon 1875); San Francisco (F. Lamson-Scribner in 1899); Mission Hills (Michener and Bioletti 123).

The original description of the above species, which is quoted in full below, applies so well to the specimens referred to, that taken in connection with some other circumstances, we feel little hesitation in taking it up. So far as we know, it has not before been recognized, except by Fournier (Mex. Pl. **2**: 127), who seems to have somewhat misinterpreted it.

The plant has been generally referred to *Bromus breviaristatus* (Hook.) Buckl. l. c. It is the same as the specimen of *Bromus pauciflorus* Nutt. in Herb. Acad. Nat. Sci. Phil., upon which *B. breviaristatus* Buckl. was founded. Hooker appears to have included it in his *Ceratochloa breviaristata*, as there is a spikelet of it in the Gray Herbarium, which Dr. Gray has marked "original spec." The distribution of this plant by Hooker under the name *breviaristata* led Torrey, Gray, and Thurber to a misinterpretation of the species, for as already mentioned under *B. unioloides*, Hooker's drawing and type clearly belong to that species.

We have been unable as yet to locate Nees's type specimen; but the fact that Hooker distributed this plant from Douglas's collection, taken in connection with the fact as shown in a season's work in the region of the Columbia that this species and its varieties are the most common bromes met with, there is left little doubt that we have the plant Nees described.

This species is quite variable. Toward the north it passes into *B. aleutensis* Trin., and southward into *B. polyanthus*, while near the Pacific coast it passes through var. *latior* into *B. carinatus*.

Index Kewensis gives this as a synonym of *B. ciliatus* L., but this is evidently a mistake. The following is the original description taken from Steudel l. c.:

"*Bromus marginatus* Nees (mpt. sub.: *Ceratochloa*).

"Foliis vaginisque hirsutis; paniculæ erectæ strictæ radiis subsimplicibus; spiculis oblongo-lanceolatis compressis utrinque convexis pubescenti-scabris 6–8-floris; seta valvula sua 7-nervia duplo breviore. ♃ Douglas legit ad fluv. Columbia St. Louis."

31*α*. BROMUS MARGINATUS LATIOR n. var.

A larger and stouter plant than the species, sometimes reaching 17 or 18 dm. high. Panicle larger, 2–3 dm. long, with longest lower branches 10–20 cm. long, awn usually slightly longer, sometimes reaching 6 or 7 mm. Otherwise like the species.

Type No. 1615, collected by C. L. Shear, Walla Walla, Washington.

General distribution about the same as for the species, but in lower altitudes, being most common in the foothills and valleys down to about 1,600 meters.

Specimens examined.—*New Mexico:* Santa Fe (Dr. George Vasey). *Utah:* Springdale (M. E. Jones 5242). *Colorado:* Ft. Collins (L. H. Pammel). *Arizona:* Little Laramie River (T. A. Williams 2233). *Wyoming:* Bozeman (C. L. Shear 476; P. A. Rydberg 2213); no locality (J. W. Blankinship); Sheep Creek (P. A. Rydberg 3308; F. L. Scribner 16); Spanish Creek (P. A. Rydberg 3337); East Gallatin Swamp (P. A. Rydberg 3171); Spear Basin (P. A. Rydberg 3155). *Idaho:* head of Little Potlatch River (Sandberg, Heller, & McDougal 434, 331); Lewiston (A. A. & E. G. Heller 3202); Moscow (L. F. Henderson 2829); St. Josephs River (J. B. Leiberg 1298). *Washington:* Walla Walla (C. L. Shear 1615); Pullman (C. V. Piper 1738). *Oregon:* (W. C. Cusick 650); Prineville (J. B. Leiberg 314). *California:* (J. G. Lemmon).

This plant has been collected by wool waste heaps at North Berwick, Maine. It is also escaped from cultivation about Ames, Iowa, from which place it is represented in the herbarium by C. R. Ball's Nos. 33 and 148.

Forms of this plant in Oregon and Washington connect with *B. carinatus hookerianus*, which is generally distinguished by its smoother spikelets and longer awns.

31*β*. BROMUS MARGINATUS SEMINUDUS n. var.

This differs from the species in the following particulars: Usually more leafy, but less pubescent or, in some cases, nearly smooth throughout; spikelets with empty glumes glabrous or slightly scabrous on the nerves; flowering glumes somewhat scabrous or scabrous-puberulent.

Type No. 1811 C. L. Shear, collected on open mountain side 5 miles above Wallowa Lake, Oregon.

Distribution about the same as for the species.

Specimens examined.—*Utah:* Santa Clara (M. E. Jones 5118b); Ogden (T. A. Williams 2477; S. M. Tracy 322). *Wyoming:* Sherman (L. H. Pammel); Bear Lodge (T. A. Williams 2648, 2633); Sundance (D. Griffiths 984); Spread Creek (F. Tweedy 64). *Idaho:* Beaver Canyon (C. L. Shear 573); Forks of Boise River (L. F. Henderson 3271). *Yellowstone National Park:* (J. N. Rose 222). *Montana:* Spanish Creek (P. A. Rydberg 3028, 3104); Gallatin County (F. Tweedy); Bridger Pass (P. A. Rydberg 3219); Bozeman (P. A. Rydberg 2233½). *Assiniboia:* Cypress Hills (J. Macoun 13040). *Washington:* (G. R. Vasey; Kirk Whited 2, 4); Montesano (A. A. & E. G. Heller 3979). *Oregon:* Mountains above Wallowa Lake (C. L. Shear 1811, 1789, 1777, 1785, 1803, 1810, 1794, 1815, 1766, 1775, 1796); Wallowa Lake (C. L. Shear 1751, 1762); Hood River (L. F. Henderson); Hoover Creek (J. B. Leiberg 138); Government Meadows, Blue Mountains (C. L. Shear 1668, 1666); Blue Mountains (C. L. Shear 1679, 1688, 1674); Cathedral

Rocks, Crater Lake (Coville & Leiberg 379); Ravena (A. B. Leckenby); Portland (B. Killin); Grants Pass (T. Howell 251); hills northwest of Corvallis (M. Craig). *California:* (J. G. Lemmon 438; C. A. Purpus 5421); Donner Lake (L. H. Pammel); San Jacinto Mountains (H. M. Hall 785); mountains south of Dixie Valley (J. B. Davy); no locality (Vasey).

This form is the connecting link between *B. marginatus* and *B. polyanthus.* It, like the species, is a mountain plant extending up to about 3000 meters altitude or somewhat higher. In the lower altitudes the panicle tends to become longer and laxer, passing into variety *latior.*

FIG. 34.—*Bromus polyanthus:* a, empty glumes with two florets; b, dorsal view of a flowering glume.

32. BROMUS POLYANTHUS Scribn. nom. nov. *Bromus multiflorus* Scribn. U. S. Dept. Agr. Div. Agrost. Bul. 13: 46. 1898. Not Weig. 1772, et al. (Fig. 34.)

A rather stout, erect, short-lived perennial. Culm smooth or puberulent at the nodes, mostly 6–10 dm. high. Sheaths *typically smooth*, rarely sparsely pilose; ligule about 2 mm. long, rounded, subentire; blades *linear-lanceolate, mostly scabrous, especially above.* Panicle elongate, erect, branches usually short and erect or slightly spreading. Spikelets mostly 3–3.5 cm. long, laterally compressed, carinate, rather densely 7–11 flowered; empty glumes broad, *smooth or somewhat scabrous,* the lower 3-nerved, rather obtuse or subacute, 6–8 mm. long, the upper 5–7 nerved, most obtuse, 9–11 mm. long; flowering glume 7 nerved, 13–15 mm. long, *smooth or scabrous,* rather obtuse, emarginate with a broad, hyaline margin; awn 4–6 mm. long; palea a little shorter than its glume.

Type No. 4024, collected by Aven Nelson at Battle Lake, Sierra Madre Mountains, Wyoming.

General distribution: Colorado and Utah north to Montana and Oregon.

SPECIMENS EXAMINED.—*Colorado:* Glenwood Springs (Shear & Bessey 1300); Buffalo Pass (Shear & Bessey 1434, 1474, 1484); Yampa (Shear & Bessey 1421); Red Dirt Divide, Routt County (Shear & Bessey 1347, 1362, 1385); near Pallas (Shear & Bessey 1411); Middle Park (G. Vasey); Robinson (C. L. Shear 1045); Rabbit Ears Pass (C. F. Baker 4). *Utah:* Logan (P. A. Rydberg 2347); Alta (M. E. Jones 1111); Fairview (M. E. Jones 5554m). *Idaho:* Beaver Canyon (C. L. Shear 596;

P. A. Rydberg 2342); Montpelier (T. A. Williams 2553). *Wyoming:* Bear Tooth Mountains (W. H. Forwood); Bear Lodge Mountains (T. A. Williams 2619); Jacksons Lake (W. H. Forwood); Elk Mountain (A. Nelson 4098); Buffalo Fork (F. Tweedy 65); Rife's Ranch (A. Nelson 3759, 3827); Seminole Mountains (A. Nelson 4921); Sierra Madre Mountains (A. Nelson 4035). *Montana:* Lima (C. L. Shear 560½). *Oregon:* Powder River Mountains (C. V. Piper 2529).

The above species is very closely related to *B. marginatus*, into which it passes and of which it should perhaps be regarded as a variety. It differs chiefly from the typical form of *B. marginatus* in being smoother throughout.

32a. BROMUS POLYANTHUS PANICULATUS n. var. (Fig. 35.)

A rather tall, leafy plant with a larger, laxer, more spreading panicle than the species and having the upper part somewhat nodding. The leaves are rather broader and the spikelets slightly narrower, with the florets rather looser in flower and the awn sometimes reaching 7 mm. long.

Type No. 333 Tracy, Earle, and Baker, collected in West Mancos Canyon, Colorado, altitude about 3,000 meters.

Fig. 35.—*Bromus aleutensis:* a, empty glumes with two florets; b, dorsal view of a flowering glume.

Specimens examined.—*Colorado:* West Mancos Canyon (Baker, Earle and Tracy 333); Trimble Springs (Baker, Earle & Tracy 4301); Parrott (Baker, Earle & Tracy 4297); Buffalo Pass (Shear & Bessey 1493); Sheep Horn Divide (Shear & Bessey 1552); La Veta (C. L. Shear 812). *Utah:* Gunnison (L. F. Ward 286). *Arizona:* Strawberry Creek (D. T. McDougal 707).

This plant bears the same relation to the species that *B. marginatus latior* does to its species. Its distribution is more southern in general and most frequent in lower altitudes.

33. BROMUS ALEUTENSIS Trin. Griseb. in Ledeb. Flor. Ross. **4**: 361. 1853. (Fig. 35.)

A rather tall, stout perennial, *with a lax, suberect panicle* and broad, linear-lanceolate leaves. Culms 5–10 dm. high, erect, stout, usually slightly pubescent just below

the nodes; internodes generally 3 to 4. Sheaths usually equaling or exceeding the internodes, coarsely striate, usually sparsely retrorsely pilose; ligule 4–5 mm. long, subrotund above, somewhat laciniate; blades mostly 20–35 cm. long, usually sparsely pilose on both sides. Panicle, 12–20 cm. long; lower branches *1–2, bearing 1–3 spikelets somewhat nodding*, becoming more or less rigid and erect when old. Spikelets oblong-lanceolate, compressed, 2.5–3.5 cm. long, 7–9 mm. broad, 3–6-flowered; empty glumes broad, subequal, the lower distinctly 3-nerved, subacute, upper distinctly 5 or obscurely 7 nerved, obtuse, 10–13 mm. long, usually scabrous, especially on the nerves; *flowering glume broadly lanceolate distinctly 7-nerved*, with a broad membranous margin, smooth to scabrous-pubescent, *averaging about 15 mm. long*, bidentate at the apex, awned; awn stout, scabrous, *mostly 9–11 mm. long*; palea nearly equaling its glume, acute, ciliate-pectinate on the keels. Pachilla thinly pubescent, about 3 mm. long.

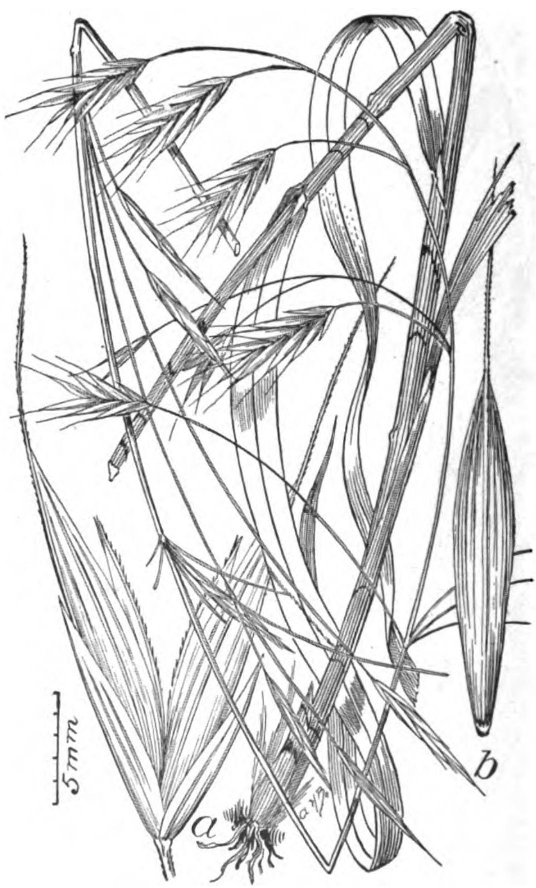


FIG. 36.—*Bromus sitchensis: a*, empty glumes with two florets showing the paleæ; *b*, dorsal view of a flowering glume.

General distribution: Atka and Unalaska.

Type in Herb. Ledebour from Unalaska, collected by Eschscholtz.

SPECIMENS EXAMINED.—*Unalaska* (W. H. Evans 550 in 1897; Dr. A. Kellogg 142 in 1867; S. Applegate, no number or date; M. W. Harrington in 1871–72). *Atka* (L. M. Turner 1194 in 1880).

This species is very closely related to *B. marginatus*. The original description says "spikes glabrous," but we have amended it to include forms having scabrous-pubescent flowering glumes. Such forms coming from St. Petersburg Herb. and evidently determined by Trinius are in the Gray Herb. We have seen no specimens with perfectly glabrous spikelets.

34. BROMUS SITCHENSIS Bong. Obs. Veg. Sitch. 173. 1831. (Fig. 36.)

A tall, stout, leafy perennial. Culm smooth, nearly erect, 12–18 dm. high. Sheaths shorter than the internodes, *smooth;* ligule large, rounded entire or somewhat torn, 3–5 mm. long; blades *linear-lanceolate, 2–4 dm. long, 7–12 mm. broad, sparsely*

short-pilose above, smooth beneath. Panicle *large, lax, drooping, 2.5–3.5 dm. long; lower branches 2–4, long, weak, spreading, usually bearing 1–3 spikelets on long, slender pedicels.* Spikelets 2.5–3 cm. long, 6–8 mm. wide, oblong-lanceolate, strongly laterally compressed, rather loosely flowered; empty glumes acute, smooth or scabrous on the nerves, the lower lanceolate, 3-nerved, 8–9 mm. long, the upper broader, 5–7 nerved, 10–12 mm. long; flowering glume broadly lanceolate, acute, about 12–14 mm. long, 7-nerved, smooth or scabrous, shortly bidentate at the apex, *with a straight awn 6–9 mm. long;* palea considerably shorter than its glume, short pectinate-ciliate on the keels.

Type from the Island of Sitka.

General distribution: Alaska south to Washington, apparently near the coast.

SPECIMENS EXAMINED.—*Alaska:* Unalaska (Dr. A. Kellogg 142); Hope Island (Dr. A. Kellogg 143); Yes Bay (Thos. Howell 1722A)—a form approaching *B. aleutensis* in its shorter awn and somewhat broader flowering glume. *Cascade Mountains:* 49 n. lat. (Dr. Lyall in 1859)—a form approaching *B. carinatus hookerianus.*

This species is related to *B. aleutensis* and *B. carinatus hookerianus,* but most closely to the latter, from which it differs in the typical form in its more robust form, laxer panicle with fewer spikelets and much longer, weaker, spreading branches.

FIG. 37.—*Bromus carinatus: a,* empty glumes with three florets; *b,* dorsal view of a flowering glume.

35. BROMUS CARINATUS Hook. & Arn. Bot. Beech. Voy. Suppl. 403. 1841. *Bromus hookerianus minor* Scribn. in Beal, Grass. N. A. 2 : 614. 1896. *Bromus oregonus* Nutt. in Herb. Acad. Nat. Sci. Phil. (Fig. 37.)

An annual or biennial with erect culm, linear leaves, and erect or suberect panicle. Culm about 5–8 dm. high, slightly pubescent at the nodes. Sheaths mostly shorter than the nodes, *retrorsely soft pilose;* ligule 3–4 mm. long, sublaciniate; blades flat, *mostly narrow,* about 1–2.5 dm. long, 3–6 mm. broad, *thinly pilose both sides.* Panicle pyramidal, somewhat lax, about 1.5–2.5 dm. long; lower branches about 3, spreading, or somewhat drooping. Spikelets lanceolate to suboblong-lanceolate, compressed, *about 2.5–3 cm. long and 5 mm. broad,* 5–9 flowered; empty glumes *lanceolate, acute, glabrous to slightly scabrous-pubescent;* the lower distinctly 3 or sometimes obscurely 5 nerved, 7–9 mm. long; the upper 5 or sometimes obscurely 7 nerved, 9–11 mm. long; flowering glume lanceolate, obscurely

7-nerved, *puberulent or short-pubescent,* about 13–16 mm. long, *bifid at the apex and tapering into an awn 7–10 mm. long;* palea nearly equaling its glume, ciliate-pectinate on the keels; rachilla slender, somewhat pubescent, about 3 mm. long.

General distribution: Nevada, California, Oregon, and Washington.

Type collected by Douglas near Monterey or San Francisco, California.

SPECIMENS EXAMINED.—*Nevada:* St. Thomas Canyon (M. E. Jones 5069x in 1894). *Washington:* western Klickitat County (W. N. Suksdorf 173 in 1885); Walla Walla (C. L. Shear 1579 in 1889); Fair Haven (C. V. Piper 2607 in 1897); Tacoma (A. B. Leckenby in 1898). *Oregon:* Eight Dollar Mountain (T. Howell in 1884, distributed as *Bromus hookerianus minor* Scribn.; 252 in 1887, large form with broad spikelets and glumes approaching *B. marginatus*); McMinnville (C. L. Shear 1617 in 1899). *California:* Santa Cruz (C. L. Anderson 128 in 1889); no locality (C. L. Anderson 120 in 1888; 76 in 1888; 96 in 1888—this specimen is about identical with specimens in the Gray herbarium from Douglas's collection which are evidently typical; 109 in 1888); Bear Valley, San Bernardino Mountains (S. B. Parish 3298 in 1894); San Bernardino Valley (S. B. and W. F. Parish 1534 in 1882); San Gorgonio (S. B. and W. F. Parish 1533—this is a rather broad-leafed, very robust form); San Diego (C. R. Orcutt 1178 in 1884; 511 in 1884); San Jose (Mrs. Bush in 1880); San Luis Obispo (Mrs. Summers); Mendocino County (J. W. Blankinship 35 in 1893); near Mendocino (H. E. Brown 747 in 1898); San Diego County (G. R. Vasey in 1880); Mariposa County (J. W. Congdon in 1895); Sonoma (E. Samuels 222); (J. M. Bigelow, Whipple expedition collection in 1853–54); Mount Hamilton (C. Rutter 92 in 1895); near Mount Shasta (E. Palmer 2626 in 1892—this is the form which Nuttall called *Bromus oregonus;* it differs from typical *B. carinatus* in its somewhat broader glumes and slightly denser pubescence); southeastern California (E. Palmer 546 in 1896); New York Falls (Geo. Hansén 627); Berkeley (J. Burtt Davy 204 in 1893); Kellogg and Harford 1113 in 1868 and 1869); Los Angeles (S. M. Tracy 168 in 1887); Laguna (L. Schoenfeldt 3624 in 1894).

35α. **BROMUS CARINATUS CALIFORNICUS** (Nutt.) n. comb. *Bromus californicus* Nutt. in Herb. Acad. Nat. Sci. Phil.

A form intermediate between typical *B. carinatus* and *B. carinatus hookerianus.* Differing from the former in its nearly smooth leaves and sheaths and its flowering glumes merely scabrous. From the latter it differs in its narrower spikelets and glumes.

Nuttall's specimen in the Philadelphia Academy herbarium labeled "u. Calif." is a mere scrap showing only two small panicles from different plants and having a few small upper leaves. This form must be near *B. hookeri schaffneri* Fourn, judging from his description.

The following specimens from southern and Lower California have been referred to this variety. *Lower California:* Todos Santos Bay (Miss F. E. Fish 12); Potrero Valley (C. R. Orcutt, in 1889). *California:* San Diego (D. Cleveland 13); (C. R. Orcutt 511a).

35β. **BROMUS CARINATUS HOOKERIANUS** (Thurb.) n. comb. *Bromus hookerianus* Thurb. in Wilkes U. S. Exp. Exped. **17**[2]: 493. 1874. *Ceratochloa grandiflora* Hook. Fl. Bor. Am. **2**: 253. 1840. *Bromus virens* Buckl. Proc. Acad. Nat. Sci. Phil. 98. 1862. Not *B. unioloides virens* Nees, Agrost. Braz. 470. 1829. *Bromus nitens* Nutt. in Herb. Acad. Nat. Sci. Phil. (Fig. 38.)

A robust plant, larger in all its parts than the species. Panicles erect, 2–4 dm. long; branches spreading. Spikelets 5–10 flowered, 3–4 cm. long, 5–7 mm. broad; empty glumes slightly broader and less acute than in the species; flowering glumes also broader and *scabrous* with a broad hyaline margin and an awn 10–15 mm. long.

General distribution: California to Washington and Idaho. Type in the herbarium of the Royal Gardens, Kew, England, collected on the "plains of the Columbia."

SPECIMENS EXAMINED.—*California:* San Jose (ex herb. State Normal School); Ojai Valley (F. W. Hubby 36). *Oregon:* Gearhart (C. L. Shear 1734½, a form approaching *B. marginatus*); near Rhea Creek (J. B. Leiberg 65); (W. C. Cusick 1321). *Washington:* Klickitat County (W. N. Suksdorf 16); Seattle (C. V. Piper and E. C. Smith 944); (C. V. Piper 818). *Idaho:* Valley of Clearwater River (Sandberg, Heller & McDougal 166).

This variety passes by various intermediate forms into the species and also into *B. marginatus*. It is so inconstant in character that it does not seem advisable to try to hold it to specific rank. Through the kindness of Sir W. T. Thiselton-Dyer, director of Kew Gardens, we have been permitted to examine a spikelet from the original specimen collected by Douglas on "Upland dry soils on the Multoonah (Oregon) 1826." This leaves no doubt as to the form which Hooker took as the type of his *Ceratochloa grandiflora*.

FIG. 38.—*Bromus carinatus hookerianus:* *a*, an entire spikelet; *b*, flowering glume without the awn; *c*, caryopsis showing plumose apex; *d*, sterile flower showing the lodicules.

35γ. BROMUS CARINATUS DENSUS n. var.

A tall, stout, erect plant, with a dense panicle 3 dm. long. It differs from the species in its stouter habit, smoother leaves and sheaths, the leaves being smooth or merely scabrous, and the panicle with numerous rays, some of the lower being compound and bearing many spikelets. The spikelets are narrow, 2–2.5 cm. long, with the florets subdistant, showing the slender scabrous rachilla when in flower; empty glumes as in the species; flowering glume coarsely scabrous, about 1 cm. long; awn slender, 5–7 mm. long.

Type collected by Blanche Trask "about opuntia" on San Nicholas Island, California, No. 12, April, 1897. The specimen cited shows only the panicle and the upper leaf. We should be inclined to give this specific rank but for the fact that accompanying specimens from the same island show forms connecting it with the species.

35δ. BROMUS CARINATUS LINEARIS n. var. (Fig. 39.)

A somewhat cæspitose plant, with slender, nearly erect culms and very narrow linear leaves. It differs from the typical form of the species in its narrow, subracemose panicle, 5–10 cm. long, and in its shorter and narrower leaves. The spikelets

are slightly broader, glumes not so acute, and awn somewhat stouter and shorter, 5–7 mm. long.

Type in the herbarium of the Department of Agriculture collected by Dr. G. R. Vasey in California in 1875.

35ε. BROMUS CARINATUS ARIZONICUS n. var.

Sheaths and leaves more scantily pilose than in the species. Panicle erect, narrow pyramidal to subracemose, spikelets and glumes slightly broader than in the species, empty glumes glabrous; *flowering glumes sparsely scabrous-puberulent*, less acute; *awn shorter, 5–6 mm. long.*

Type in the Herbarium U. S. Department of Agriculture, collected by C. G. Pringle in Santa Cruz Valley, Tucson, Arizona, May 3, 1884.

SPECIMENS EXAMINED.—*Arizona:* fifteen miles above Pierces Ferry (M. E. Jones 5077ar); Tucson (J. W. Toumey 748, 798); Bradshaw Mts. (J. W. Toumey 27); near Congress (C. R. Orcutt 2531). *Texas:* El Paso (M. E. Jones 19a).

This may be the *Bromus hookeri schlechtendalii* Fourn. Mex. Pl. **2** : 127. 1886, as it differs only in a few minor particulars from the original description of that variety. It also closely approaches *B. marginatus seminudus.*

Fig. 39.—*Bromus carinatus linearis: a*, empty glumes with two florets; *b*, dorsal view of a flowering glume.

36. BROMUS LACINIATUS Beal, Grass. N. A. **2** : 615. 1896. (Fig. 40.)

An erect perennial with a lax, somewhat secund panicle and laterally compressed purplish spikelets. Culm about 5–7 dm. high, smooth or slightly pubescent at the nodes. Sheaths *smooth;* ligule about 2 mm. long, subtruncate, laciniate; blades *smooth*, both sides linear-lanceolate, ascending, somewhat stiff, 5–20 cm. long by 3–5 mm. broad. Panicle suberect or somewhat drooping, lax, about 10–17 cm. long, lower rays 3–4, slender, bearing 1–2 spikelets. Spikelets about 5-flowered, *2–2.5 cm. long, about 5 mm. broad*, lower somewhat drooping, laterally compressed; empty glumes *smooth*, lower broad-lanceolate, acute, 3-nerved, 6–7 mm. long, upper broader, obtuse, 5–7-nerved, 8–9 mm. long; flowering glume ovate-lanceolate, *chartaceous, scabrous, 5–7-nerved, 11–13 mm. long*, with two short subacute teeth at the apex, and an awn *5–6 mm. long;* palea about equaling its glume.

Type No. 4897 C. G. Pringle, Pl. Mex. 1894, Sierra de San Felipe, alt. 9500 ft., State of Oaxaca.

The above description is from the specimen of the above number in the National Herbarium. The species has not been reported from the United States, but it may extend this side the Mexican border. It resembles very closely small forms of *B. polyanthus paniculatus*.

SPECIES EXCLUDED.

Bromus giganteus L. Sp. Pl. **1**: 77. 1753.=**Festuca gigantea** Willd.

Bromus secundus J. S. Presl in C. B. Presl, Reliq. Haenk. **1**: 263. 1830. "Hab in sinu Nootka"= **Festuca rubra secunda** (Presl.) Scribn. Rept. Mo. Bot. Gard. **10**: 39. 1899.

Bromus subulatus Griseb. in Ledeb. Fl. Ros. **4**: 358. 1853.=**Melica subulata** Scribn. Proc. Acad. Nat. Sci. Phil. **1885**: 47. 1885.

SPECIES DOUBTFUL OR UNKNOWN.

Bromus depauperatus, J. S. Presl in C. B. Presl, Reliq. Haenk. **1**: 263. 1830. "Radice repente, culmo glabro, foliis planis vaginisque scabris, panicula secunda nutante simplici laxa patentissima, locustis subtrifloris, paleis inferioribus teretiusculis trinerviis scabris. Hab. in sinu Nootka. ♃." "Similis *Bromo aspero*, Radix repens, firma, crassa, fusca, multas fibras emittens. Culmus sedecim pollices altus inferne crassitie pennæ anatinæ, erectus teres, striatus glaber. Nodi fusci, scabri. Vaginæ elongatæ, arcte adpresse, striatæ, versus collum scabriusculæ. Ligula: margo angustissimus, fimbriolatus. Folia vaginis longiora duas et dimidiam lineam lata, linearia, plana, utrinque scabra. Panicula quinque pollices longa, laxa, secunda, nutans. Rhachis inferne teretiuscula glabra, superne angulata scabra. Rami alternatim binati, flexuosi, angulati, scabri, paucas locustas gerentes. Pedunculi locusta breviores, ramis conformes. Locustæ lanceolatæ, tri-bifloræ, virescenti flavæ. Glumæ locusta triplo breviores, ovato-lanceolatæ, setaceo-terminatæ, glabræ, inferior minor uninervia, superior fere duplo longior trinervia. Flosculi subulati, teretes, distantes. Rhachicula flexuosa, scabriuscula. Palea inferior ovato-lanceolato in apicem

Fig. 40.—*Bromus laciniatus*: *a*, empty glumes with two florets, *b*, dorsal view of a flowering glume.

acutissimum protracta, apice bidentata dentibus setiformibus, extus scabriuscula, trinervia. Arista paulo brevior, scabra, recta, palea superior paululum brevior, acutissima apice bimucronata, binervia, bicarinata, carinis scabra, pagina exteriore scabriuscula."

Judging from the description of the spikelets and the florets, this is not a true *Bromus*, although Dr. Beal in his Grasses of North America regards it as such, and has referred to it collections by Bolander and Kellogg from San Diego, California.

Bromus segetum H. B. K. Nov. Gen. et Sp. Pl. I. 151. 1815. "B. culmo glabro; foliis vaginisque pilosis; panicula subsimplici, verticillata, secunda, nutante, ramis rhachique hispido-scabris; spiculis lineari-oblongis, subsexfloris; glumis paleisque glabriusculis; arista longitudine paleæ. Crescit in cultis regni Quitensis, prope Lloa, Villa de Ibarra et Chillo, alt. 1340–1500 hexap. ⊙ Floret Januario. Culmi erecti, tri-aut quadripedales, simplices, teretes, striati, glabri. Nodi pilosi. Folia linearia, acuminata, plana, striata, externe piloso-scabra, interne pilosa. Vaginæ striatæ pilosæ. Ligula ovata, obtusa, glabra. Panicula subsimplex, secunda, verticillata, nutans, pedalis, ramis longissimis, nigro-purpurascentibus, hispido-scabris, spiculas duas aut tres, rarius unicam ferentibus. Rhachis piloso-scabra. Spiculæ lineari-oblongæ, quinque-aut sexfloræ. Glumæ inæquales, inferior duplo brevior, lanceolato-subulata, apice scabriuscula, superior oblonga, acuminata, subaristata, trinervia, virescens, glabriuscula, spicula triplo brevior. Paleæ lanceolato-oblongæ, glabriusculæ, subæquales, inferior acuminata, subquinquenervia, superior bicarinata, angustior et tenuior, apice bidentata, in carinis ciliato-scabra. Arista subterminalis, recta, scabra, longitudine paleæ. *Bromo arvensi* simillimus."

Bromus setaceus Buckl. Proc. Acad. Nat. Sci. Phil. **14**: 98. 1862. "Culmo erecto 2–3 pedali; vaginis inferioribus glabris, superioribus marginibus et faucibus parce villosis; ligulis 2–3 lin. lon. apice laciniatis; foliis glanis pubescentibus margine ciliatis 4–6 policaribus 3–4 lin. latis; panicula diffusa composita 6–8 policari 4–5 polic. latis; radiis 5–7 nis basi nudis hirsutis ad apicem compositis; ramulis 3–4 nis, unispicatis; spiculis 4–5 floris oblongo obovatis; glumis parum inæqualibus carinatis lineari lanceolatis ciliatis acuminatis, marginibus apicibusque albo-hyalinis, superiore 3–5 nervia; valvula inferiore lanceolata 5–7 nervia ciliata apice bifida et aristata; seta 6 lin. lon. Northern Texas."

"The longest of the lower branches of the panicle 3–4 inches in length and the shorter branches 1–2 inches long, all destitute of spikes excepting near their tops; spikes loosely flowered; internodes on the rachis 1–2 inches long; pedicels 4–6 lines in length; spikes without the bristle about ½ inch long, loosely flowered; upper florets abortive, 2–3 united, appearing to the naked eye like one with 2–3 bristles."

Dr. Gray says in his notes on Buckley's paper published in the volume cited that this is *B. sterilis* L., but the description does not apply closely enough to that species to warrant us in accepting it as a synonym of that. Nuttall's and Buckley's specimens, kindly loaned us by the Philadelphia Academy, did not contain this plant, so it must remain doubtful for the present.

INDEX.

[Synonyms and pages referring to descriptions of species are in *italics*.]

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BULLETIN No. 24. Agros. 73.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF AGROSTOLOGY.

[Grass and Forage Plant Investigations.]

STUDIES

ON

AMERICAN GRASSES.

I. SOME RECENT COLLECTIONS OF MEXICAN GRASSES.
By F. LAMSON-SCRIBNER and ELMER D. MERRILL.

II. NOTES ON PANICUM NITIDUM LAM., PANICUM SCOPARIUM LAM., AND PANICUM PUBESCENS LAM.
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III. MISCELLANEOUS NOTES AND DESCRIPTIONS OF NEW SPECIES.
By F. LAMSON-SCRIBNER and CARLETON R. BALL.

ISSUED JANUARY 9, 1901.

WASHINGTON:
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1900.

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1900.

LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
DIVISION OF AGROSTOLOGY,
Washington, D. C., October 3, 1900.

SIR: I have the honor to transmit herewith the manuscript of three papers embodying studies in systematic agrostology made in this Division, and I respectfully recommend their publication under the general title of "Studies on American Grasses," in conformity with papers of like character previously published by this Division.

Respectfully,

F. LAMSON-SCRIBNER,
Agrostologist.

HON. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

ILLUSTRATIONS.

I.—SOME RECENT COLLECTIONS OF MEXICAN GRASSES.

By F. Lamson-Scribner and Elmer D. Merrill.

INTRODUCTION.

In this paper are enumerated 227 species and varieties of Mexican grasses, of which 11 species and 1 variety are described as new. The specimens on which the list is based include the following recent collections from Mexico.

Forty-four specimens collected by Mr. C. L. Smith in 1894, chiefly in the State of Vera Cruz; 100 specimens collected in 1897 by Dr. J. N. Rose in the Sierra Madre Mountains and along the Pacific coast; 122 specimens collected by Dr. E. Palmer in 1896, chiefly on the western coast; 50 specimens collected by Dr. E. Palmer in 1897, chiefly from the State of Durango; 98 specimens collected by Dr. E. Palmer in 1898, chiefly from the State of Coahuila; a collection by Mr. C. G. Pringle in 1896 from the State of Colima, and another in 1899 by the same collector from the State of Vera Cruz; and 40 specimens collected by Mr. E. W. Nelson in 1899 from the State of Chihuahua. In addition to these collections are also included the few species secured by Messrs. Rose and Hough in 1899, a few by Mr. Pringle previous to 1896, and several by Mr. J. G. Smith in 1892.

Since the publishing of Fournier's Mexican Plants in 1881, considerable work has been done on the grass flora of Mexico, but the publications on the subject are widely scattered throughout the periodical literature. The only recent articles dealing entirely with Mexican grasses are "A List of the Grasses Collected by E. Palmer in the Vicinity of Acapulco, Mexico, 1894–95," by F. Lamson-Scribner;[1] "Some Mexican Grasses Collected by E. W. Nelson in Mexico, 1894–95," by F. Lamson-Scribner and Jared G. Smith;[1] and Circular No. 19 of the Division of Agrostology on "New or Little Known Mexican Grasses," which was issued January 2, 1900. In order to make the present paper more complete, the grasses enumerated in Circular No. 19 have been included, each species that was considered in that circular being marked with an asterisk.

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[1] Bul. 4, Division of Agrostology, U. S. Department of Agriculture.

LIST OF SPECIES.

Euchlæna mexicana Schrad. Ind. Sem. Hort. Goett. (1832); Linnæa, **8**: 25 (1833). Sierra Madre Mountains, altitude 1,600 m., State of Durango, 3513 J. N. Rose, August 15, 1897; State of Durango, 743 E. Palmer, September, 1896.

A plant very much resembling corn, found along water ditches at Navocyana Ranch, very valuable for forage, passing under the common name of "Maizillo."

Tripsacum fasciculatum Trin. in Steud. Nom. ed. 2, **2**: 712 (1841).

Durango, State of Durango, 537 E. Palmer, August, 1896; on the road near Huejuquilla, State of Jalisco, 3570 J. N. Rose, August 25, 1897.

TRIPSACUM PILOSUM Scribn. & Merrill, sp. nov. (Fig. 1.)

Fig. 1.—*Tripsacum pilosum* Scribn. & Merrill: *a* A staminate spikelet.

A stout, erect perennial about 15 dm. high, with broad, lanceolate, pubescent leaves. Culms about 1 cm. in diameter at the base, smooth below, pilose with rather short white hairs below the panicle; nodes smooth; sheaths longer than the internodes, subcompressed above, scabrous, the lower ones strongly tuberculate-hispid; ligule very short, truncate; leaf blades 4 to 6 dm. long, 2 to 3 cm. wide, acuminate, gradually tapering to the narrow base, strongly strigose-pubescent on both sides or sometimes somewhat pilose beneath, very strongly serrulate-scabrous on the margins. Inflorescence terminal and axillary, fasciculate; branches of the terminal inflorescence about 2 dm. long, erect; the lower pistillate spikelets few, the upper staminate ones numerous, about 8 mm. long, green or purple, the outer glumes faintly 7 to 11 nerved, acute or somewhat obtuse, scabrous on the keel and margins near the apex.

A very distinct species, at once recognized by its broad and rather soft pubescent leaves and hispid sheaths.

Collected on the road between Colotlan and Bolanos, State of Jalisco, 2841 J. N. Rose, September 7, 1897.

***Ischæmum latifolium** Kunth, Rev. Gram. **1**: 168 (1835).

Under the spray of the Cascade in the Barranca of Texola, near Jalapa, altitude 1,100 m., 8106 C. G. Pringle, April 30, 1899.

Trachypogon montufari Nees, Agrost. Bras. 342 (1829).

Las Sedas, altitude 2,000 m., State of Oaxaca, 953 C. L. Smith, September 8, 1894; Durango, State of Durango, 383 E. Palmer, July, 1896.

Elionurus barbiculmis Hack. in DC. Monog. Phan. **6**: 339 (1889).

Durango, State of Durango, 549 E. Palmer, August, 1896; near San Juan Capistrano, State of Zacatecas, 2407 J. N. Rose, August 18, 1897.

Elionurus tripsacoides H. B. K. in Willd. Sp. Pl. **4**: 941 (err. typ. 741) (1805).

Jalapa, State of Vera Cruz, 1623½ C. L. Smith, 1894.

Andropogon contortus L. Sp. Pl. 1045 (1753). (*Heteropogon contortus* R. & S. Syst. **2**: 836 (1817).)

Durango, State of Durango, 540 E. Palmer, August, 1896; Bolanos, State of Jalisco, 2938 J. N. Rose, September 10–19, 1897.

Andropogon liebmanni raripilis Hack. in DC. Monog. Phan. **6**: 413 (1889).

In the Sierra Madre Mountains, near Santa Teresa, Territorio de Tepic, 2222 J. N. Rose, August 12, 1897.

Andropogon macrourus Michx. Fl. Bor. Am. **1**: 56 (1803).

San Antonio Valley, State of Oaxaca, 970 C. L. Smith, September 1, 1894; Durango, State of Durango, 251 E. Palmer, June, 1896.

Andropogon melanocarpus Ell. Sk. Bot. S. C. and Ga. **1**: 146 (1817) (*Heteropogon melanocarpus* Benth. Journ. Linn. Soc. **19**: 71 (1881).)

In the Sierra Madre Mountains, west of Bolanos, State of Jalisco, 2596 J. N. Rose, September 15–17, 1897.

Andropogon nutans incompletus Hack. in DC. Monog. Phan. **6**: 531 (1889).

Las Sedas, State of Oaxaca, 917 C. L. Smith, September, 1894.

ANDROPOGON PRINGLEI Scribn. & Merrill, sp. nov.

An erect cæspitose perennial 9 to 11 dm. high, with slender culms, short leaves, and slender racemes 3 to 6 cm. long, terminal on the culm or its branches. Culms cylindrical, purplish, very smooth; nodes glabrous; sheaths much shorter than the internodes, glabrous, striate, rather loose, the lowermost compressed, the upper ones somewhat inflated; ligule very short, truncate, ciliate-fringed with short hairs; leaf-blades pale green, those of the innovations linear, 8 to 11 cm. long, 1 to 2 mm. wide, pilose, with long white hairs on the upper surface near the base, smooth beneath, those of the culm rather rigid, linear-lanceolate, acute, 2 to 6 cm. long, 3 to 4 mm. wide, plane or folded, minutely strigose-pubescent at the throat, strongly serrulate-scabrous on the keel and margins near the apex, otherwise smooth. Racemes 3 to 4, subdigitate, rarely solitary, somewhat inclosed by the upper sheath or finally exserted; common rachis 1 to 2 cm. long; axis of the racemes 7 to 11 jointed, subflexuous, pilose with long white hairs, smooth and flattened on one side. Sessile spikelets linear-lanceolate, acute or acuminate, 6 to 8 mm. long, about twice exceeding the joints of the rachis; first glume lanceolate, acute, 2-toothed at the apex, scabrous on the keels above. otherwise glabrous, plane or slightly sulcate; second glume equaling the first, 1-nerved, acute, glabrous except at the scabrous apex; third glume about as long as the second, hyaline, smooth; flowering glume about 4 mm. long, hyaline, smooth, faintly 3-nerved, deeply cleft at the apex, bearing a slender geniculate awn 10 to 14 mm. long, which is twisted below the geniculation, scabrous above. Stamens one, about 1 mm. long. Callus-hairs about 1 mm. long. Pedicellate spikelets much smaller than the sessile ones, reduced to one or two purplish glumes, very narrowly linear-lanceolate, about 5 mm. long, scabrous at the apex; pedicels slender, slightly enlarged above, about three-fourths as long as the sessile spikelet, rather densely silky-bearded with erect or spreading white hairs about 4 mm. long.

Type specimen 6577 C. G. Pringle, Valley of Mexico, Federal District, October 23, 1896.

This species belongs to the subgenus *Arthrolophis* and is related to the group containing *Andropogon liebmanni* Hack., but differs from this and other related species in its swollen upper sheaths, much larger sessile spikelets, stouter and longer less pubescent racemes, which at first sight bear some resemblance to those of *A. provincialis* Lam.

Andropogon saccharoides Swartz, Prodr. Veg. Ind. Occ. 26 (1788).

Saltillo, State of Coahuila, 4 E. Palmer, April, 1898; 810 E. Palmer, September, 1898; near Casas Grandes, State of Chihuahua, 6342 E. W. Nelson, August 30, 1899.

Andropogon saccharoides barbinodis (Lag.) Hack. in DC. Monog. Phan. **6**: 494 (1889). (*Andropogon barbinodes* Lag. Gen. et Sp. 3 (1816).)

Near Plateado, State of Zacatecas, 2758 J. N. Rose, September 3, 1897.

Andropogon saccharoides leucopogon (Nees) Hack. in DC. Monog. Phan. **6**: 496 (1889). (*Andropogon leucopogon* Nees, Linnæa, **19**: 694 (1845).)

Durango, State of Durango, 538 E. Palmer, August, 1896.

Andropogon saccharoides perforatus (Trin.) Hack. in DC. Monog. Phan. **6**: 496 (1889). (*Andropogon perforatus* Trin. in Fourn. Mex. Pl. **2**: 59 (1881).)

Santiago Papasquiaro, State of Durango, 469 E. Palmer, August, 1896.

Andropogon saccharoides torreyanus (Steud.) Hack. in DC. Monog. Phan. **6**: 495 (1889). (*Andropogon torreyanus* Steud. Nom. ed. 2, **1**: 98 (1840).)

Jalapa, State of Vera Cruz, 1623 C. L. Smith, 1894; Durango, State of Durango, 250 E. Palmer, June, 1896.

Andropogon tener Kunth, Rev. Gram. **2**: 565 (1835).

Sienga, State of Durango, 858 E. Palmer, November, 1896.

Anthephora elegans Schreb. Beschr. Gras. **2**: 105. *t, 44* (1772–1779).

Colima, State of Colima, 146 E. Palmer, 1897.

Hilaria cenchroides H. B. K. Nov. Gen. et Sp. Pl. **1**: 117 (1815).

Durango, State of Durango, 379, 540 E. Palmer, July, 1896; Huejuquilla, State of Jalisco, 2542 J. N. Rose, August 25, 1897, growing on the banks of water ditches in alkali bottoms.

Hilaria mutica Benth. Journ. Linn. Soc. **19**: 62 (1881).

Torreon, State of Coahuila, 506 E. Palmer, October, 1898.

Ægopogon geminiflorus H. B. K. Nov. Gen. et Sp. Pl. **4**: 133, *t. 43* (1820).

Sierra de San Felipe, State of Oaxaca, 914, 1816 C. L. Smith, 1894; near Plateado, State of Zacatecas, 2791 J. N. Rose, September 4, 1897; Sierre Madre Mountains, 10 miles north of Pachico, State of Chihuahua, 6294 E. W. Nelson, August 25, 1899.

Nazia aliena (Spreng.) Scribn. U. S. Dept. Agr. Div. Agros. Bul. **17**: 28, *fig. 324* (1899). (*Lappago aliena* Spreng. Neue Entd. **3**: 15 (1822).)

Durango, State of Durango, 763 E. Palmer, October, 1896; Saltillo, State of Coahuila, 396 E. Palmer, September, 1898, in cemeteries and waste places.

Arundinella auletica Rupr. Bul. Acad. Brux. **9**: 242 (1842).

Jalapa, State of Vera Cruz, 1892 C. L. Smith, 1894.

* **Paspalum candidum** Kunth, Mém. Mus. Par. **2**: 68 (1803). (See Kew Index.)

Barranca of Texola, near Jalapa, State of Vera Cruz, altitude 1,100 m., 7884 C. G. Pringle, April 30, 1899.

Paspalum conjugatum Berg. Act. Helv. **7**: 129. *t. 8* (1772).

Colima, 16 E. Palmer, July, 1897, in low, wet bottom lands.

Paspalum distichum L. Amoen. Acad. **5**: 391 (1760).

Durango, State of Durango, 192 E. Palmer, June, 1896; Saltillo, State of Coahuila, 259, 391 E. Palmer, 1898. This grass, commonly called "sacate de grama," is found about ponds and water courses, cows and horses being very fond of it. It is used medicinally as a blood purifier, a hot tea being made which is taken internally.

Paspalum inops Vasey, Contr. U. S. Nat. Herb. **1**: 281 (1893).

Near Plateado, State of Zacatecas, 2781 J. N. Rose, September 3, 1897.

PASPALUM NOTATUM Flügge, Monog. 106 (1810).

Las Sedas, altitude 2,000 m., State of Oaxaca, 933 C. L. Smith, September 8, 1894; Colima, 138 E. Palmer, August, 1897.

PASPALUM PANICULATUM L. Syst. Nat. ed. 10, 855 (1758-59).

Coatzacoalcos, Isthmus of Tehuantepec, State of Vera Cruz, 1053 C. L. Smith, March 16, 1895; Rosario, State of Sinaloa, 1545 J. N. Rose, July 7, 1897; Colima, 18 E. Palmer, July, 1897.

Paspalum plicatulum Michx. Fl. Bor. Am. **1**: 45 (1803).

Coatzacoalcos, Isthmus of Tehuantepec, State of Vera Cruz, 1054 C. L. Smith, March 12, 1895; between Rosario and Acaponeta, State of Sinaloa, 1885 J. N. Rose, July 28, 1897; foothills of the Sierra Madre Mountains, near Pedro Paulo, Territorio de Tepic, 1961 J. N. Rose, August 3, 1897; near Acaponeta, Territorio de Tepic, 3294 J. N. Rose, July 30, 1897; Colima, 144 E. Palmer, August, 1897.

PASPALUM PROSTRATUM Scribn. & Merrill, sp. nov. (*Pseudoceresia*).

A low, diffuse, spreading perennial with slender culms, broad rachis, and ovate-lanceolate leaves. Culms, 2 to 3 dm. long, prostrate, finally erect, glabrous, rooting at the lower nodes; nodes glabrous; sheaths loose, compressed, striate, smooth below, sparingly pilose above and on the margins, the lower ones shorter than or about equaling the internodes, the upper one elongated; ligule nearly obsolete; leaf-blades 1.5 to 3.5 cm. long, 5 to 10 mm. wide, rounded or truncate at the base, acute at the apex, pilose beneath and more sparingly so above, serrulate-scabrous on the cartilaginous margins, mid-nerve somewhat prominent on the lower surface for one-third the length of the leaf, vanishing. Primary axis 6 to 10 cm. long, glabrous; racemes 5 to 10, solitary, remote, alternate, spreading, bearded at the axils, the lower ones 2.5 cm. long, the upper ones shorter; partial rachis 2 to 3 mm. wide, thin, undulate-striate on the back, abruptly acute, smooth or serrulate-scabrous on the margins. Spikelets alternate, imbricate in two rows, short-pedicellate, elliptical-ovate, obtuse, smooth, 2 mm. long; first glume equaling the flowering glume, obtuse, thin, hyaline, 3-nerved, the midnerve faint, the marginal ones more prominent; second glume equaling the flowering glume, more firm in texture, 3 or faintly 5 nerved, slightly sulcate; flowering glume elliptical, obtuse, very smooth. Palea equaling the glume, smooth, plane.

Type specimen 3343 C. G. Pringle, low lands near Patzcuaro, State of Michoacan, November 9, 1890.

This species belongs in the section *Pseudoceresia* and is distinguished from *Paspalum gracile* Rudge by its habit of growth, shorter leaves, solitary racemes, and larger spikelets. Distributed as *Paspalum gracile* Rudge.

PASPALUM PROSTRATUM PYGMÆUM Scribn. & Merrill, var. nov.

A low, densely cæspitose form 3 to 5 cm. high, with loose, pilose sheaths, densely pilose leaves 1 to 2.5 cm. long, 1 to 3 mm. wide, and short inflorescence of 1 to 3 spikes, which are 1 cm. long or less. Rachis and spikelets as in the species.

Type specimen 7167 C. G. Pringle, Pedrigal, altitude 2,600 m. (8,500 feet), Valley of Mexico, Federal District, September 30, 1896. In dry places by the railroad track.

Paspalum pubiflorum Rupr. Bul. Acad. Brux. **9**: 237 (1842).

Durango, State of Durango, 871 E. Palmer, November, 1896; Torreon, State of Coahuila, 515 E. Palmer, October, 1898; near Colotlan, State of Jalisco, 3602 (in part) J. N. Rose, August 28, 1897.

PASPALUM ROSEI Scribn. & Merrill, sp. nov. (Fig. 2.)

A densely cæspitose, simple, erect, glabrous perennial, about 6 dm. high with elongated leaves and long-exserted inflorescence of 2 or 3 slender, divergent spikes. Culms slender, smooth; nodes pilose; sheaths striate, scabrous, short; ligule very short, ciliate-fringed; leaves linear, plane or folded, acute, those of the

culm 1 or 2, short; basal leaves numerous, 1 to 3 dm. long, glabrous beneath, more or less pilose with scattered hairs on the upper surface near the base. Inflorescence long-exserted, the branches slender, spreading, 5 to 7 cm. long, undulate, smooth, somewhat pubescent or pilose at the axils. Spikelets 4 mm. long, lanceolate, acute, alternate, very short pedicellate, appressed; first and second glumes equal, lanceolate, acuminate, 5-nerved, sparingly pilose with

FIG. 2.—*Paspalum rosei* Scribn. & Merrill: *a*, *b*, spikelets; *c*, same with the outer glumes removed.

scattered hairs, especially at the base; flowering glume oblong, obtuse, 3 mm. in length, glabrous, bearing a tuft of few short hairs at the apex. Palea linear-lanceolate, convex, equaling the glume.

Foothills of the Sierra Madre Mountains, between Pedro Paulo and San Blascito, 1995 J. N. Rose, August 4, 1897.

Related to *Paspalum neesii* Kunth, but differing in its much smaller spikelets and plane, smooth leaves.

Paspalum squamulatum Fourn. Mex. Pl. **2**: 11 (1881).

Jalapa, State of Vera Cruz, C. L. Smith, 1894.

Paspalum tenellum Willd. Enum. Hort. Berol. 89 (1809). (*P. elegans* Flügge, Monog. 183 (1810).)

Lava beds, Pedrigal, Valley of Mexico, Federal District, 6474 C. G. Pringle, September 1, 1896.

Paspalum velutinum (DC.) Kunth, Rev. Gram. **1**: 27 (1835). (*Milium velutinum* DC. Cat. Hort. Monsp. 126 (1813).)

Sandy fields, base of Sierra de Ajusco, altitude 1,900 m., Federal District, 6623 C. G. Pringle, October 29, 1896. This specimen is certainly identical with what Fournier[1] considered to be this species, and there can be little doubt but that it is the same as *Milium velutinum* DC. In habit very much resembling *Panicum sanguinale* L., and intermediate between the section *Digitaria* of the genus *Panicum* and the genus *Paspalum*.

Eriochloa punctata (L.) W. Hamilton, Prodr. Pl. Ind. Occ. 5 (1825). (*Milium punctatum* L. Amoen. Acad. **5**: 392 (1759): *Eriochloa polystachya* H. B. K. Nov. Gen. et Sp. Pl. **1**: 95 (1815).)

Durango, State of Durango, 524, 736 E. Palmer, August and September, 1896; Topolobampo, State of Sinaloa, 242 E. Palmer, September, 1897; Torreon, State of Coahuila, 509 E. Palmer, October, 1898, in rich, moist soil along the Nassus River.

Isachne disperma Doell, in Mart. Fl. Bras. **2**[2]: 274 (1877).

Jalapa, State of Vera Cruz, 1804 C. L. Smith, 1894.

***Panicum albomaculatum** Scribn. U. S. Dept. Agr. Div. Agros. Cir. **19**: 2 (January, 1900).

A rather slender, erect, sparingly branched perennial, 6 to 8 dm. high, with striate sheaths, short, ciliate ligules, and spreading panicles 12 to 16 cm. long. Nodes glabrous, the overlapping margins of the sheaths very densely ciliate or subvillous. Leaf-blades 7 to 12 cm. long, 5 to 10 mm. wide (when dry), very acute, rounded at the somewhat clasping base, scabrous on the nerves below, glabrous above, sharply serrulate-scabrous on the narrowly cartilaginous margins, which are ciliate near the base. Axis and branches of the panicle glabrous, the lower longer branches 8 to 10 cm. long. Spikelets ovate, obtuse, 2.5 mm. long; first glume obtuse, 1-nerved, subremote, clasping the pedicel; the second and third glumes 7-nerved, thinly pubescent with short hairs, about equaling the smooth and shining fourth glume; the third glume has a thin, short palea. The exposed

FIG. 3.—*Panicum badium* Scribn & Merrill: *a, b*, spikelets enlarged; *c*, same with outer glumes removed.

[1] Mex. Pl. **2**: 8 (1881).

portion of the culm and sheath purplish, the latter (in the type) white-spotted with small oblong spots or blotches.

Dry, rocky hills, Patzcuaro, State of Michoacan, 5203 C. G. Pringle, October 10, 1892.

Allied to *Panicum scabriusculum* Ell., but readily distinguished by its larger spikelets, less densely flowered panicles, and distinctly cartilaginous, serrulate leaf margins. The plant throughout is more slender.

Panicum avenaceum H. B. K. Nov. Gen. et Sp. Pl. **1**: 99 (1815).

Durango, State of Durango, 741 E. Palmer, August, 1896.

PANICUM (SYNTHERISMA) BADIUM Scribn. & Merrill, sp. nov. (Fig. 3.)

A slender, erect, cæspitose perennial, 4 to 7 dm. high, with linear-lanceolate leaves and digitate panicles of 3 to 5 erect spike-like branches 4 to 7 cm. long. Culms geniculate and compressed below, glabrous or with few long white hairs above; nodes glabrous; sheaths loose, shorter than the internodes, striate, pilose, with rather long spreading hairs; ligule about 2 mm. long, acute or obtuse, hyaline except on the narrow brown margin; leaf-blades 5 to 20 cm. long, 5 to 6 mm. wide, plane, acute, slightly narrowed at the base, pilose on both sides with few, long, white hairs. Inflorescence exserted, the branches slender, glabrous. Spikelets in pairs, one short-pedicellate, one long-pedicellate, ovate, acute, 2.5 mm. long; first glume obsolete; second and third glumes densely pubescent with rather short brown hairs, the former about three-fourths as long as the flowering glume, acute, 3-nerved, the latter equaling the flowering glume, 3 to 5 nerved; flowering glume narrowly ovate, acute or short-acuminate, dark brown, obscurely striate or pitted.

Sierra de San Felipe, State of Oaxaca, altitude between 2,300 and 2,800 m., 915 C. L. Smith, October 6, 1894.

Distributed as *Anthænantia villosa* Beauv. which it somewhat resembles in the pubescence of the outer glumes, but very different in habit and inflorescence. Related to *Panicum phæothrix* Trin. Icon. Gram. **1**: *t. 91* (1828) (*P. ferrugineum* Kunth, Rev. Gram. **1**: 39; **2**: 501, *t. 163* (1835), but readily distinguished by its much broader, pilose leaves, pilose sheaths and culms, and longer second glume.

Panicum bulbosum H. B. K. Nov. Gen. et Sp. Pl. **1**: 99 (1815).

Santiago Papasquiaro, State of Durango, 467 E. Palmer, August, 1896; near Monte Escobedo, State of Jalisco, 2609 J. N. Rose, August 26, 1897; near Dolores, Territorio de Tepic, 2053 J. N. Rose, 1897; between Agnacata and Dolores, 3361 J. N. Rose, August 6, 1897; between Pedro Paulo and San Blascito, Territorio de Tepic, 1999 J. N. Rose, August 4, 1897.

Panicum cæspitosum Swartz, Fl. Ind. Occ. **1**: 146 (1797).

Durango, State of Durango, 433 E. Palmer, August, 1896.

Panicum colonum L. Syst. Nat. ed. 10, 870 (1758–59).

Rosario, State of Sinaloa, 1544 J. N. Rose, July 7, 1897; between Acaponeta and Pedro Paulo, Territorio de Tepic, 1923 J. N. Rose, August 2, 1897; Colima 169 E. Palmer, 1897; Torreon, State of Coahuila, 508 E. Palmer, October, 1898; Parras, 454 E. Palmer, October, 1898; near Colonia Garcia, State of Chihuahua, 6187 E. W. Nelson, August 1, 1899; near Pachico, State of Chihuahua, 6298, 6301 E. W. Nelson, August 26, 1899.

Panicum compactum Swartz, in Griseb. Fl. Brit. W. Ind. 552 (1864).

Near Huasemote, State of Durango, 3502 J. N. Rose, August 15, 1897.

Panicum crus-galli L. Sp. Pl. 56 (1753).

San Francisco, State of Vera Cruz, 1329 C. L. Smith, 1894; Durango, State of Durango, 252, 730 E. Palmer, June–September, 1896; Santiago Papasquiaro, State of Durango, 466 E. Palmer, August, 1896; near Colotlan, State of Jalisco, 3606 J. N. Rose, August 29, 1897; below Pachico, State of Chihuahua, 6244 E. W. Nelson, August 22–24, 1899; between Casas Grandes and Sabinal, State of Chihuahua, 6355a E. W. Nelson, September 4–5, 1899.

Common in low ground about water courses and even in shallow water, reaching to a height of 5 or 6 feet. It is a very prolific species, eagerly eaten by domestic animals. The seeds, which become dark at maturity, are much eaten by birds.

Panicum crus-galli muticum Vasey, Contr. U. S. Nat. Herb. **3**: 37 (1892).

Saltillo, State of Coahuila, 380 E. Palmer, September, 1898.

Panicum fasciculatum Swartz, Prodr. Veg. Ind. Occ. 22 (1788).

Rosario, State of Sinaloa, 1834 J. N. Rose, July 24, 1897.

Panicum fimbriatum (Link) Kunth, Rev. Gram. **1**: 33 (1835). (*Digitaria fimbriata* Link, Hort. Berol. **1**: 226 (1827); *Syntherisma fimbriata* Nash, Bul. Torr. Bot. Club, **25**: 302 (1898).)

Colima, 9 E. Palmer, July, 1897, in a deep, shady ravine; Topolobampo, State of Sinaloa, 234 E. Palmer, September, 1897; Saltillo, State of Coahuila, 387 E. Palmer, September, 1898.

Panicum fuscum Swartz, Prodr. Veg. Ind. Occ. 23 (1788).

Topolobampo, State of Sinaloa, 250 E. Palmer, September, 1897, in an opening on a very stony mountain slope.

Panicum hallii Vasey, Bul. Torr. Bot. Club, **9**: 61 (1884).

Durango, State of Durango, 525 E. Palmer, August, 1896.

Panicum hirticaulum Presl, Rel. Haenk. **1**: 308 (1830).

Between Agnacata and Dolores, Territorio de Tepic, 3351 J. N. Rose, August 6, 1897; near Acaponeta, 1889, 3281 J. N. Rose, July 29, 1897; between Rosario and Acaponeta 1883, 1878 J. N. Rose, July 28, 1897 (the last four numbers are depauperate); Colima, 14, 143, 145 E. Palmer, July, 1897; Topolobampo, State of Sinaloa, 249, 251 E. Palmer, September, 1897; near Pachico, State of Chihuahua, 6297 E. W. Nelson, August 25, 1899; between Casas Grandes and Sabinal, State of Chihuahua, 6355 E. W. Nelson, September 4–5, 1899.

Panicum holciforme Steud. Nom. ed. 2, **2**: 257 (1841).

Durango, State of Durango, 253 *bis* E. Palmer, June, 1896.

***Panicum inflatum** Scribn. & Smith, U. S. Dept. Agr. Div. Agros. Cir. **16**: 5 (1899).

Gravelly banks near Jalapa, State of Vera Cruz, altitude 1,250 m., date not given, 7883 C. G. Pringle, 1899.

Panicum insulare (L.) Mey. Prim. Fl. Esseq. 60 (1818).

Durango, State of Durango, 715 E. Palmer, September, 1896.

Panicum lanatum Rottb. Act. Lit. Univ. Hafn. **1**: 269 (1778). (*P. leucophæum* H. B. K. Nov. Gen. et Sp. Pl. **1**: 97 (1815).)

Between Concepcion and Acaponeta, 1900 J. N. Rose, July 29, 1897.

***Panicum laxiflorum** Lam. Encycl. **4**: 748 (1797). (*P. xalapense* Kth.?)

A low, densely cæspitose perennial, 1.5 to 3 dm. high, with crowded, lanceolate, acute, pilose leaves and spreading, ovate panicles 4 to 5 cm. long. Culms much branched near the base, glabrous; nodes bearded with spreading hairs; sheaths pilose with soft, spreading, or reflexed hairs; ligule a dense fringe of hairs about 1 mm. long. Leaves 3 to 6 cm. long, 6 to 10 mm. wide, pilose on both surfaces with soft hairs, ciliate on the margins with long, spreading, papillate hairs. Axis of the panicle glabrous or pubescent. Spikelets oblong, obtuse, 2 mm. long; first glume broadly obtuse, about one-third the length of the spikelet, 3-nerved; the second and third glumes prominently 7-nerved, pubescent, with short, spreading hairs between the nerves.

Gravelly banks near Jalapa, State of Vera Cruz, altitude 1,250 m., 8083 C. G. Pringle, March 29, 1899; 1752 C. L. Smith, 1894.

Nearly identical with the grass from the Southern States which by recent authors has been referred to *P. laxiflorum* Lam.

Panicum maximum Jacq. Icones Pl. Rar. **1**: *t. 13* (1781-1786).

San Francisco, State of Vera Cruz, 1409 C. L. Smith, 1894.

***Panicum multirameum** Scribn. U. S. Dept. Agr. Div. Agros. Cir. **19**: 2 (January, 1900).

A rather slender, tufted perennial, 20 to 30 cm. high, with glabrous culms, densely fasciculate-branched above, bearded nodes, and glabrous or thinly pilose sheaths which are bearded at the throat. Lower culm leaves 5 to 8 cm. long, those on the branches much shorter and narrower, sparingly ciliate near the base, pubescent beneath, minutely scabrous along the margins, which are very narrowly cartilaginous. Panicles loosely flowered, 2 to 4 cm. long. Spikelets about 2 mm. long, obtuse, and 7-nerved; the second and third glumes thinly pubescent; the fourth glume subacute; the broadly obtuse first glume one-third to nearly one-half as long as the spikelet.

Gravelly hills near Jalapa, State of Vera Cruz, altitude 1,250 m., 7882 C. G. Pringle, 1899; Orizaba, State of Vera Cruz, 593 J. G. Smith, February 17, 1892.

Allied to *Panicum ciliosum* Nash, but smaller, nodes more distinctly bearded, and leaves less ciliate.

Panicum obtusum H. B. K. Nov. Gen. et Sp. Pl. **1**: 98 (1815).

Torreon, State of Coahuila, 504 E. Palmer, October, 1898; Saltillo, 394 E. Palmer, September, 1898; San Luis Potosi, 1631 E. Palmer, 1898; between Casas Grandes and Sabinal, State of Chihuahua, 6352 E. W. Nelson, September 4–5, 1899. Low places often overflowed. Extensively used as a purgative under the name of "purga de paridas."

***Panicum pilosum macranthum** Scribn. U. S. Dept. Agr. Div. Agros. Cir. **19**: 1 (January, 1900).

Secondary axes or branches of the panicle (longer lower ones) 3.5 cm. long, pilose with papillate hairs about 2 mm. long. Spikelets 2.2 mm. long, the outer glumes strongly scabrous on the keel near the apex, as are the fruiting glume and palea.

Swamps near Jalapa, State of Vera Cruz, altitude 1,230 m., 8195 C. G. Pringle, May 21, 1899.

Panicum plantagineum Link, Hort. Berol. **1**: 206 (1833).

Near Colotlan, State of Jalisco, 3602 (in part) J. N. Rose, August 28, 1897.

***Panicum polycaulon** Nash, Bul. Torr. Bot. Club, **24**: 200 (1897).

Low places, borders of swamps, Minatitlan, State of Vera Cruz, 555 Jared G. Smith, June 30, 1892.

Panicum repens L. Sp. Pl. ed. 2, 87 (1762–63). (*P. littorale* Vasey, Bot. Gaz. **3**: 106 (1878); *P. gouini* Fourn. Mex. Pl. **2**: 28 (1881).)

Coatzacoalcos, Isthmus of Tehuantepec, State of Vera Cruz, 913 C. L. Smith, March 8, 1895.

Panicum reticulatum Torr. in Marcy's Explor. Red Riv. La. 299 (1852).

Between Rosario and Acaponeta, 1884 J. N. Rose, July 28, 1897.

Panicum sanguinale L. Sp. Pl. 57 (1753).

Colima, 148 E. Palmer, 1897, in a deep, shady ravine; Durango, State of Durango, 766 E. Palmer, October, 1896. Common in fence rows, etc.

Panicum sanguinale ciliare (Retz.) Vasey, U. S. Dept. Agr. Div. Bot. Bul. **8**: 23 (1889). (*Panicum ciliare* Retz. Obs. **4**: 16 (1779–1791).)

Rosario, State of Sinaloa, 1541 J. N. Rose, July 7, 1897.

PANICUM (DIMORPHOSTACHYS) UNISPICATUM Scribn. & Merrill, sp. nov.

A slender, erect perennial, 8 to 15 dm. high, with glabrous culms, sparingly pilose sheaths, lanceolate or linear-lanceolate leaves, and long-exserted solitary spikes 9 to 12 cm. long. Culms very smooth throughout; nodes smooth; sheaths equaling or shorter than the internodes, loose, striate, ciliate on the margins, smooth below, sparingly tuberculate-pilose above; ligule hyaline, membranaceous, lacerate, about 2 mm. long; the throat rather densely bearded, immediately

above the ligule, with rigid white hairs about 5 mm. long. Leaf-blades 15 to 30 cm. long, 6 to 12 mm. wide, plane, scarcely narrowed at the abruptly rounded and somewhat clasping base, gradually tapering to a very slender, attenuate and involute, filiform apex, very sparingly tuberculate-pilose on both sides or nearly smooth beneath, ciliate and scabrous on the cartilaginous margins. Inflorescence a pale green, long-exserted, erect or very slightly curved spike, solitary or 2 from the upper sheath, 9 to 12 cm. long, the spikelets in pairs, one sessile and one short-pedicellate, in two rows on one side of the smooth rachis. Spikelets ovate, acute, glabrous, 3 to 4 mm. long; first glume of the sessile spikelet one-third as long as the flowering glume, or shorter, obtuse, hyaline, not increasing in size toward the apex of the spike; that of the pedicellate spikelet lateral or twisted so as to appear in a lateral position, lanceolate, acuminate, about three-fourths as long as the flowering glume, 1-nerved, scabrous at the apex; second glume ovate, acute, glabrous, 3 or faintly 5 nerved, equaling the flowering glume in length; third glume concave, 3-nerved, slightly exceeding the flowering glume, subtending a lanceolate, hyaline, 2-nerved palea as long as the glume; flowering glume ovate, acute, minutely striate or pitted throughout. Palea similar in texture and markings, plane or slightly concave.

Type specimen 6717 C. G. Pringle, Valley of Oaxaca, State of Oaxaca, July 13, 1897.

This species belongs to the group on which Fournier based his genus *Dimorphostachys*,[1] and is related to the South American *Panicum monostachyum*,[2] but is abundantly distinct, differing from the description and plate in Kunth's Rev. Gram. 380, *t. 104*, in its larger size, smooth nodes and culms, broader and not soft pilose leaves, larger spikelets, and much larger first glume of the sessile spikelet; moreover Kunth does not mention or figure a long lateral first glume of the pedicellate spikelet in his description of *P. monostachyum*, which is so prominent in our species.

Distributed as *Paspalum schaffneri* Griseb.

***Panicum viscidellum** Scribn. U. S. Dept. Agr. Div. Agros. Cir. **19**: 2 (January, 1900).

A slender, ascending or erect, finally branching perennial, 6 to 10 dm. high, with numerous bearded nodes, pubescent internodes, pubescent sheaths, lanceolate, acute, pubescent leaves, and ovate, exserted panicles 5 to 7 cm. long. Leaves 5 to 8 cm. long, 1 to 2 cm. broad, cordate-clasping at the base; ligule pilose. Panicle branches somewhat viscid, the lower ones 2.5 to 3 cm. long. Spikelets 1.8 mm. long, obovate, obtuse, or subacute, the 7-nerved second and third glumes glabrous or with a few scattering hairs.

Gravelly banks near Jalapa, State of Vera Cruz, altitude 1,250 m., 8089 C. G. Pringle, October, 1899; same locality, 1617 C. L. Smith, 1894; in thickets near Mirador, 323 Liebmann, 1841.

Related to *Panicum scoparium* Lam. (*P. viscidum* Ell.), but stems much more slender, leaves shorter and less rigid, panicles smaller, as are also the spikelets, which are nearly smooth. Fournier, in his enumeration of the grasses of Mexico, refers this grass to *P. commelinæfolium* Rudge,[3] and cites *P. multiflorum* Ell. and *P. microcarpon* "Michx." as synonyms. I have not Rudge's work, "Plantæ Guianæ," in which *P. commelinæfolium* is illustrated, and upon which illustration Fournier based his determination of Liebmann's plant, but our grass is certainly not *P. multiflorum* Ell. (*P. polyanthes* Schultes), nor does it agree with available descriptions of *P. commelinæfolium*. *P. microcarpon* Ell., Sk. Bot. S. C. and Ga. 127, 1817, not Muhl., is the grass now usually referred to *P. barbulatum* Mx.

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[1] Mex. Pl. **2**: 13 (1881).

[2] H. B. K. Nov. Gen. et Sp. Pl. **1**: 96 (1815).

[3] Mex. Pl. 2: 20 (1881).

Panicum velutinosum Nees in Trin. Gram. Panic. 144 (1826).
State of Durango, 2280 J. N. Rose, August 14, 1897; Colima, 149 E. Palmer, August, 1897.

Oplismenus cristatus Presl, Rel. Haenk. **1**: 323 (1830).
Ometepe Island, Nicaragua, 1075 C. L. Smith, 1894.

Chætochloa composita (H. B. K.) Scribn. U. S. Dept. Agr. Div. Agros. Bul. **4**: 39 (1897). (*Setaria composita* H. B. K. Nov. Gen. et Sp. Pl. **1**: 110 (1815).)
Saltillo, State of Coahuila, 378, 449 E. Palmer, September, 1898; on the road from Casas Grandes to Sabinal, State of Chihuahua, 6368 E. W. Nelson, September 4–5, 1899. Along fence rows, etc.

Chætochloa grisebachii (Fourn.) Scribn. U. S. Dept. Agr. Div. Agros. Bul. **4**: 39 (1897). (*Setaria grisebachii* Fourn. Mex. Pl. **2**: 45 (1881).)
Monte Alban, altitude 1,750 to 1,900 m., near Oaxaca, State of Oaxaca, 939 C. L. Smith, October 8, 1894; Saltillo, State of Coahuila, 385 E. Palmer, September, 1898; Sierra Madre Mountains, 10 miles north of Pachico, State of Chihuahua, 6298 E. W. Nelson, August 25, 1899. A weed in gardens.

Chætochloa grisebachii ampla Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 36 (1900).
Durango, State of Durango, 728 E. Palmer, September, 1896.

Chætochloa imberbis (Poir.) Scribn. U. S. Dept. Agr. Div. Agros. Bul. **4**: 39 (1897). (*Panicum imberbe* Poir. in Lam. Encycl. Suppl. **4**: 272 (1816).)
Oaxaca, State of Oaxaca, 935 C. L. Smith, 1894.

Chætochloa imberbis geniculata (Lam.) Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 12 (1900). (*Panicum geniculatum* Lam. Encycl. **4**: 727 (1797).)
Jalapa, State of Vera Cruz, 1547 C. L. Smith, 1894; Durango, State of Durango, 378, 381, 539 E. Palmer, July, 1896; Federal District, 6419 C. G. Pringle, 1896; Colotlan, State of Jalisco, 3607 J. N. Rose, August 29, 1897; Colima, 17 E. Palmer, 1897, in rich, shady thickets in a fruit garden.

Chætochloa latifolia Scribn. U. S. Dept. Agr. Div. Agros. Bul. **11**: 44 *pl. 3* (1898).
Durango, State of Durango, 879 E. Palmer, November, 1896, growing under bushes in deep ravines.

Chætochloa latifolia breviseta Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 31 (1900).
Santiago Papasquiaro, State of Durango, 470 E. Palmer, August, 1896, growing under bushes in a deep ravine.

Chætochloa liebmanni (Fourn.) Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 31 (1900). (*Setaria liebmanni* Fourn. Mex. Pl. **2**: 44 (1881).)
Durango, State of Durango, 716 E. Palmer, September, 1896; Rosario, State of Sinaloa, 1840 J. N. Rose, July, 1897; Topolobampo, 233 E. Palmer, September, 1897; Colima, 142 E. Palmer, August, 1897, under bushes on mountain slopes, many plants together.

Chætochloa liebmanni pauciflora (Vasey) Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 33 (1900). (*Chamæraphis caudata pauciflora* Vasey in Beal, Grasses N. A. **2**: 158 (1896).)
Near Acaponeta, Territorio de Tepic, 3303 J. N. Rose, July 31, 1897; Colima, 8 E. Palmer, July, 1897, in shady places on embankments.

Chætochloa longipila (Fourn.) Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 22 (1900). (*Setaria longipila* Fourn. Mex. Pl. **2**: 47 (1881).)
Between Agnacato and Dolores, Territorio de Tepic, 2017 J. N. Rose, August 6, 1897.

Chætochloa macrostachya (H. B. K.) Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 29 (1900). (*Setaria macrostachya* H. B. K. Nov. Gen. et Sp. Pl. **1**: 110 (1815).)
Durango, State of Durango, 872 E. Palmer, November, 1896.

Chætochloa purpurascens (H. B. K.) Scribn. & Merrill, U. S. Dept. Agr. Div. Agros. Bul. **21**: 13 (1900). (*Setaria purpurascens* H. B. K. Nov. Gen. et Sp. Pl. **1**: 90 (1815).)

In the Sierra Madre Mountains, near Santa Teresa, Territorio de Tepic, 3417 J. N. Rose, August 10, 1897; Saltillo, State of Coahuila, 383, 384 E. Palmer, September, 1898.

Setariopsis auriculata (Fourn.) Scribn. Field Col. Mus. Bot. Ser. **2**: 289 (1896). (*Setaria auriculata* Fourn. Mex. Pl. **2**: 43 (1881).)

Bolanos, State of Jalisco, 2899 J. N. Rose, September 10–19, 1897, small form; Colima, 139 E. Palmer, August, 1897, in low places in a graveyard.

Ixophorus unisetus (Presl) Schlecht. Linnæa, **31**: 420 (1861–62). (*Urochloa uniseta* Presl, Rel. Haenk. **1**: 319 (1830).)

Colima, 141 E. Palmer, July 1, 1897, a strong-growing grass found in low places in a graveyard.

Cenchrus echinatus L. Sp. Pl. 1050 (1753).

Durango, State of Durango, 880 E. Palmer, October, 1896; Rosario, State of Sinaloa, 3110 J. N. Rose, June 21, 1897; Colotlan, State of Jalisco, 3603 J. N. Rose, August 29, 1897.

Cenchrus myosuroides H. B. K. Nov. Gen. et Sp. Pl. **1**: 115, *t. 35* (1815).

Durango, State of Durango, 868 E. Palmer, November, 1896; near San Juan Capistrano, State of Zacatecas, 2453 J. N. Rose, August 21, 1897.

Cenchrus tribuloides L. Sp. Pl. 1050 (1753).

Durango, State of Durango, 196 E. Palmer, June, 1896; near Casas Grandes, State of Chihuahua, 6327 E. W. Nelson, August 30, 1899.

Pennisetum longistylum Hochst. Flora, **24**: 1 (1841).

Topolobampo, State of Sinaloa, 231 E. Palmer, September, 1897. One bunch of this grass found near a water ditch and said to have been accidentally introduced from Florida.

Homalocenchrus hexandrus (Swartz) Britton, Trans. N. Y. Acad. Sci. **9**: 14 (1889). (*Leersia hexandra* Swartz, Prodr. Veg. Ind. Occ. 21 (1788).)

Durango, State of Durango, 195 E. Palmer, June, 1896. Wet banks and in shallow water about ponds and lagoons, extending far from the shore by a network of cane-like rootstocks. A very nutritious grass, cattle not only eagerly devouring the short tops, but even keeping their heads under water in order to reach the submerged portions.

Phalaris canariensis L. Sp. Pl. 54 (1753).

Rosario, State of Sinaloa, J. N. Rose, no number, July 26–29, 1897, in a yard.

Savastana mexicana (Rupr.) Beal, Grasses N. A. **2**: 187 (1896). (*Ataxia mexicana* Rupr. Bul. Acad. Brux. **9**: 233 (1842); *Hierochloa mexicana* Benth.)

Sierra de San Felipe, altitude 3,075 m., State of Oaxaca, 940 C. L. Smith, August 28, 1894.

Aristida bromoides H. B. K. Nov. Gen. et Sp. Pl. **1**: 112 (1815).

Saltillo, State of Coahuila, 388 E. Palmer, September, 1898; between Casas Grandes and Sabinal, State of Chihuahua, 6369 E. W. Nelson, September 4–5, 1899; near Sierra En Media, State of Chihuahua, 6466 E. W. Nelson, September 24–26, 1899.

Aristida dispersa Trin. & Rupr. Agrost. **3**: 109 (1842).

Durango, State of Durango, 535, 767 E. Palmer, September–October, 1896; near Plateado, State of Zacatecas, 2703 J. N. Rose, August 31, 1897; Colotlan, State of Jalisco, 2812 J. N. Rose, September 6, 1897.

Aristida humboldtiana Trin. & Rupr. Agrost. **3**: 119 (1842).

Pedrigal, Valley of Mexico, Federal District, 6544 C. G. Pringle, October 2, 1896; Serrania de Ajusco, Federal District, 6493 C. G. Pringle, September 6, 1896.

Aristida interrupta Cav. Icon. **5**: 43 *t. 471, f. 2*, (1799).

On lava beds, Pedrigal, Valley of Mexico, Federal District, 6579 C. G. Pringle, October 2, 1896.

Aristida longiramea Presl, Rel. Haenk. **1**: 284 (1830).

Las Sedas, State of Oaxaca, 918 (in part) C. L. Smith, September, 1894.

Aristida purpurea Nutt. Trans. Am. Phil. Soc. **5**: 145 (1837).

Saltillo, State of Coahuila, 392 E. Palmer, September, 1898. A very slender form, growing among rocks on hillsides.

Aristida scabra Kunth, Rev. Gram. **1**: 62 (1835).

Santiago Papasquiaro, 472 E. Palmer, August, 1896; about Cuernavaca, State of Morelos, 6496 C. G. Pringle, September 16, 1896; Bolanos, State of Jalisco, 3694 J. N. Rose, September 10–19, 1897; east base of Sierra Madre Mountains, State of Chihuahua, 6496 E. W. Nelson, September 29, 1899.

Aristida schiedeana Trin. & Rupr. Agrost. **3**: 120 (1842).

Near Plateado, State of Zacatecas, 2793 J. N. Rose, September 4, 1897.

Aristida setifolia H. B. K. Nov. Gen. et Sp. Pl. **1**: 122 (1815).

Las Sedas, State of Oaxaca, 931, 918 (in part) C. L. Smith, September, 1894.

Stipa cærulea Presl, Rel. Haenk. **1**: 227 (1830).

Sierra de San Felipe, altitude 3,075 m., State of Oaxaca, 926 C. L. Smith, September 18, 1894.

Stipa linearifolia Fourn. Mex. Pl. **2**: 73 (1881) (?).

Saltillo, State of Coahuila, 3 E. Palmer, April, 1898. Distributed as *S. viridula* Trin., from which it is very distinct, and although not agreeing in all particulars with Fournier's description of *S. linearifolia*, there can be but little doubt as to its identity. Empty glumes equal, acuminate, 7 mm. long; flowering glume 5 mm. long, pilose with long appressed hairs; awn scabrous, 1.5–2 cm. long, twisted and twice geniculate. Leaf-blades strongly involute, 2–3 dm. long.

Stipa trochlearis Nees in Meyen, Reise, **1**: 484 (1843).

Durango, State of Durango, 532 E. Palmer, August, 1896.

Stipa virescens H. B. K. Nov. Gen. et Sp. Pl. **1**: 126 (1815).

Near Plateado, State of Zacatecas, 2750 J. N. Rose, September 2, 1897.

Muhlenbergia acuminata Vasey, Bot. Gaz. **11**: 337 (1886).

Saltillo, State of Coahuila, 379 E. Palmer, September, 1898, in rich, moist soil.

Muhlenbergia affinis Trin. Agrost. **2**: 291 (1841).

Las Sedas, State of Oaxaca, 952 C. L. Smith, September, 1894; on the road between Mesquitec and Monte Escobedo, State of Jalisco, 2614 J. N. Rose, August 26, 1897; Sierra Madre Mountains, west of Bolanos, 2984 J. N. Rose, September 15–17, 1897.

***Muhlenbergia alamosana** Vasey, Bot. Gaz. **16**: 146 (1891).

Mossy cliffs, Sierra de Tepixtlan, near Cuernavaca, altitude 2,300 m., 6994 C. G. Pringle, February 8 and March 14, 1899.

Muhlenbergia arizonica Scribn. Bul. Torr. Bot. Club, **15**: 8, *pl. 76* (1888).

Durango, State of Durango, 536, 713 E. Palmer, August, 1896.

Muhlenbergia berlandieri Trin. Agrost. **2**: 299 (1841).

Durango, State of Durango, 729 E. Palmer, September, 1896.

Muhlenbergia calamagrostidea Kunth, Rev. Gram. **1**: 63 (1835).

Durango, State of Durango, 719, 725, 881 E. Palmer, September–October, 1896; near Plateado, State of Zacatecas, 2736 J. N. Rose, September 3, 1897.

Muhlenbergia capillaris Trin. Gram. Unifl. 191 (1824).

Sienga, State of Durango, 859, 960 E. Palmer, November, 1896.

Muhlenbergia debilis Trin. Gram. Unifl. 193 (1824).

Monte Alban, altitude 1,700 m., near Oaxaca, State of Oaxaca, 938 C. L. Smith, October 8, 1894.

MUHLENBERGIA DENSIFLORA Scribn. & Merrill, sp. nov. (Fig. 4.)

An erect, rigid, cæspitose perennial, 6 to 9 dm. high, with involute, wiry leaves and dense, contracted panicles 7 to 12 cm. long. Culms cylindrical, glabrous, or

slightly scabrous, especially below the panicle, puberulent below the glabrous nodes; sheaths shorter than the internodes, striate, the lower ones glabrous, the upper scabrous; ligule 5 to 10 mm. long, acute, cleft at the apex; leaf-blades glabrous, rigid, 1 to 3 dm. long, 2 to 3 mm. wide. Panicles somewhat exserted, strict, purplish, about 1 cm. in diameter; rachis angular, scabrous; branches 1 to 2 cm. long, appressed, the lower ones generally remote; pedicels about as long as the spikelets, scabro-pubescent. Spikelets lanceolate, 5 mm. long; empty glumes subequal, 1-nerved, lanceolate, acute or acuminate, 3 to 3.5 mm. long, scabrous on the keel; flowering glume about 5 mm. long, 3-nerved, scabrous on the nerves and keel, bearing a rather stout scabrous awn at the apex, 1 to 3 mm. in length. Palea equaling the flowering glume, lanceolate, acute, or short-apiculate.

Type collected on lava beds, Serrania de Ajusco, altitude 3,000 m., Federal District, 6675 C. G. Pringle, August 13, 1897; Sierra de San Felipe, altitude 3,000 m., State of Oaxaca, 4914 C. G. Pringle, September 18, 1894; same locality, C. L. Smith, no number, 1894.

Muhlenbergia exilis Fourn. Mex. Pl. **2**: 84 (1881).

San Francisco, State of Vera Cruz, 1506 C. L. Smith, 1894; Sierra Madre Mountains, west of Bolanos, State of Jalisco, J. N. Rose, no number, September 16, 1897.

FIG. 4.—*Muhlenbergia densiflora* Scribn. & Merrill: *a*, Empty glume; *b*, spikelet; *c*, flowering glume.

Muhlenbergia flaviseta Scribn. U. S. Dept. Agr. Div. Agros. Bul. **8**: 11 (1897).

Dos Cajetas, State of Durango, 834 E. Palmer, October, 1896, abundant on the sloping sides of an arroyo.

Muhlenbergia gracilis Trin. Gram. Unifl. 193 (1824).

Sierra de San Felipe, altitude 3,075 m., State of Oaxaca, 928, 937 C. L. Smith, September, 1894.

Muhlenbergia implicata Trin. Gram. Unifl. 193 (1824).

Durango, State of Durango, 718, 769 E. Palmer, September, 1896.

Muhlenbergia laxiflora Scribn. Zoe, **4**: 389 (1894).

Durango, State of Durango, 2356 J. N. Rose, August 16, 1897.

MUHLENBERGIA LIGULATA (Fourn.) Scribn. & Merrill, n. comb. (*Chaboissaea ligulata* Fourn. Mex. Pl. **2**: 112, *t.* — (1881).)

Durango, State of Durango, 731 E. Palmer, September, 1896; 948 E. Palmer, November, 1896, in rich, moist soil in gardens and fields.

The grass here taken to be Fournier's *Chaboissæa ligulata* agrees so closely with the published description and plate of that grass that we have little hesitation in so referring it. The only apparent difference is in the awn of the flowering glume, which in No. 731 E. Palmer is 5 to 6 mm. long. Fournier does not refer to the awn and the illustration shows long-acuminate floral glumes. *Chaboissæa* is placed in the *Poaceæ* by Fournier, but if we have rightly identified Palmer's grass, it certainly belongs to the *Agrostideæ*, and, although the most of the spikelets are 2-flowered, the plant has all the characters of a *Muhlenbergia* and ought to be referred to that genus.

Muhlenbergia monticola Buckl. Proc. Acad. Nat. Sci. Phila. **1862:** 91 (1862).

Durango, State of Durango, 528 E. Palmer, August, 1896.

Muhlenbergia parviglumis Vasey, Contr. U. S. Nat. Herb. **3:** 71 (1892).

Saltillo, State of Coahuila, 417 E. Palmer, September, 1898. Not common; on very dry hillsides.

Muhlenbergia porteri Scribn. in Beal, Grasses N. A. **2:** 259 (1896).

On the road from Casas Grandes to Sabinal, State of Chihuahua, altitude 1,700 m., 6349 E. W. Nelson, September 4–5, 1899.

Muhlenbergia pringlei Scribn. Trans. N. Y. Acad. Sci. **14:** 25 (1894).

Durango, State of Durango, 529, 724 E. Palmer, August, 1896; Saltillo, State of Coahuila, 393 E. Palmer, September, 1898.

***Muhlenbergia setarioides** Fourn. Mex. Pl. **2:** 84 (1886).

Under the spray of the Cascade in Barranca of Texola, near Jalapa, State of Vera Cruz, altitude 1,100 m., 8096 C. G. Pringle, April 30, 1899.

Muhlenbergia setifolia Vasey, Bot. Gaz. **7:** 92 (1882).

Saltillo, State of Coahuila, 415 E. Palmer, September, 1898, on dry slopes, rather rare.

Muhlenbergia texana Thurb. in Coult. Man. Bot. Rocky Mountain Reg. 410 (1885).

Torreon, State of Coahuila, 511 E. Palmer, October, 1898, in bunches of mesquite bushes; a very wiry species.

Muhlenbergia vaseyana Scribn. Rept. Mo. Bot. Gard. **10:** 52 (1899). (*M. distichophylla* Am. authors, not Kunth.)

State of Oaxaca, 916 C. L. Smith, 1894; Sierra de San Felipe, altitude 3,075 m., 927 (in part) C. L. Smith, September 18, 1894; Durango, State of Durango, 542 E. Palmer, August, 1896; Sierra Madre Mountains, west of Bolanos, State of Jalisco, 3003 J. N. Rose, September 15–17, 1897.

Muhlenbergia sp. Allied to *M. gracilis* Trin., but too young for positive identification.

Sierra Madre Mountains, State of Zacatecas, 3527 J. N. Rose, August 17, 1897.

Lycurus phleoides H. B. K. Nov. Gen. et Sp. Pl. **1:** 142 (1815).

Durango, State of Durango, 526 E. Palmer, August, 1896; near Plateado, State of Zacatecas, 2794 J. N. Rose, September 4, 1897; between Casas Grandes and Sabinal, State of Chihuahua, 6356 E. W. Nelson, September 4–5, 1899.

Sporobolus cryptandrus flexuosus Thurb. in U. S. Geog. Surv. W. 100th Merid. **6:** 262 (1878).

Colonia Diaz, State of Chihuahua, 6458 E. W. Nelson, September 20–21, 1899.

Sporobolus domingensis Kunth, Enum. Pl. **1:** 214 (1833).

Sierra de San Felipe, State of Oaxaca, 51 C. L. Smith, 1894; Durango, State of Durango, 384, 737 E. Palmer, July, 1896; Topolobampo, State of Sinaloa, 236 E. Palmer, September, 1897, in open bottom lands.

Sporobolus indicus (L.) R. Br. Prodr. Fl. Nov. Holl. **1:** 170 (1810). (*Agrostis indica* L. Sp. Pl. 63 (1753).)

Jalapa, State of Vera Cruz, 1753 C. L. Smith, 1894; Durango, State of Durango, 193 E. Palmer, June, 1896; near Santa Teresa, Territorio de Tepic, 2142 J. N. Rose, 1897; near Plateado, State of Zacatecas, 2708 J. N. Rose, August 31, 1897.

Sporobolus macrospermus Scribn. in Beal, Grasses N. A. **2**: 302 (1896).

Las Sedas, altitude 2,000 m., State of Oaxaca, 921 C. L. Smith, September 29, 1894.

Sporobolus minutiflorus Link, Hort. Berol. **1**: 88 (1833).

On the road between Mesquitec and Monte Escobedo, State of Jalisco, 2613 J. N. Rose, August 26, 1897.

Sporobolus palmeri Scribn. U. S. Dept. Agr. Div. Agros. Bul. **11**: 48, *pl. 5* (1898).

Durango, State of Durango, 180 E. Palmer, June, 1896, in large bunches in alkali bottoms.

Sporobolus piliferus Kunth, Enum. Pl. **1**: 211 (1833).

Jalapa, State of Vera Cruz, 1569 C. L. Smith, 1894; fields near Jalapa, State of Vera Cruz, altitude 1,250 m., 7881 C. G. Pringle, 1899.

Sporobolus utilis Torr. Pac. R. R. Rept. **5**^{2}: 365 (1857). (*Vilfa saccatilla* Fourn. Mex. Pl. **2**: 101 (1881).)

Durango, State of Durango, 738, 739 E. Palmer, September, 1896.

Sporobolus wrightii Scribn. Bul. Torr. Bot. Club, **9**: 103 (1882).

Durango, State of Durango, 742 E. Palmer, October, 1896; between Rosario and Acaponeta, State of Sinaloa, 1867 J. N. Rose, July 28, 1897; Saltillo, State of Coahuila, 2 E. Palmer, April, 1898; City of Mexico, 4887 Rose and Hough, July 15, 1899; below Pachico, State of Chihuahua, 6243 E. W. Nelson, August 22–24, 1899; near Casas Grandes, State of Chihuahua; 6344 E. W. Nelson, August 30, 1899.

Blepharoneuron tricholepis (Torr.) Nash, Bul. Torr. Bot. Club, **25**: 88 (1898). (*Vilfa tricholepis* Torr. Pac. R. R. Rept. **4**^{5}: 155 (1857).)

Dos Cajetas, State of Durango, 833 E. Palmer, October, 1896; Serrania de Ajusco, Federal District, altitude 4,000 m., 6485 C. G. Pringle, 1896.

Epicampes bourgæi mutica Fourn. Mex. Pl. **2**: 88 (1881).

In the Sierra Madre Mountains, west of Bolanos, State of Jalisco, 3002 J. N. Rose, September 15–17, 1899.

Epicampes pubescens (H. B. K.) Presl, Rel. Haenk. **1**: 235 (1830). (*Agrostis pubescens* H. B. K. Nov. Gen. et Sp. Pl. **1**: 136 (1815).)

Sierra de San Felipe, altitude 3,075 m., State of Oaxaca, 927 (in part) C. L. Smith, September 18, 1894. Distributed as *Muhlenbergia distichophylla* Kunth. This species is also represented in the National Herbarium by 5576 C. G. Pringle, 1894, from the same locality.

Epicampes robusta Fourn. Mex. Pl. **2**: 89 (1881).

In the Sierra Madre Mountains, west of Bolanos, State of Jalisco, 2997 J. N. Rose, September 15–17, 1897.

Polypogon elongatus H. B. K. Nov. Gen. et Sp. Pl. **1**: 134 (1815).

Nombre de Dios, State of Durango, 111 E. Palmer, April, 1896; Saltillo, State of Coahuila, 2 E. Palmer, April, 1898; Durango, State of Durango, 162 E. Palmer, June, 1897.

Cinna poæformis (H. B. K.) Scribn. & Merrill, n. comb. (*Deyeuxia poæformis* H. B. K. Nov. Gen. et Sp. Pl. **1**: 146 (1815); *Cinnastrum poæforme* Fourn. Mex. Pl. **2**: 91 (1881).)

Sierra de San Felipe, State of Oaxaca, 936 C. L. Smith, August 28, 1894.

Agrostis elata Trin. Agrost. **2**: 364 (1845).

Near Colonia Garcia, in the Sierra Madre Mountains, State of Chihuahua, 6195 E. W. Nelson, August 1, 1899.

AGROSTIS ROSEI Scribn. & Merrill, sp. nov. (Fig. 5.)

A slender, erect perennial, 4 to 5 dm. high, with short, flat leaves and very open, capillary panicles, 1 to 1.5 dm. long. Culms glabrous, somewhat geniculate at

the lower nodes; sheaths shorter than the internodes, smooth, striate; ligule hyaline, obtuse, 2 mm. long; leaf-blades linear, acuminate, 5 to 8 cm. long, 2 to 3 mm. wide, scabrous on both sides and on the margins. Panicle very open, pale or purplish, the branches capillary, the lower ones verticillate, the upper ones opposite, spreading, dichotomously or verticillately branching, somewhat scabrous, the lower ones 5 to 6 cm. long; pedicels elongated, flexuous. Spikelets about 2 mm. long; empty glumes ovate-lanceolate, acute, subequal, thin, slightly scabrous on the keel above; flowering glume slightly shorter than the empty glumes, obtuse, often with 2 or 3 blunt teeth at the apex; awn attached near the base, equaling or slightly exceeding the glume, finely scabrous, straight or slightly bent near the middle. Palea very thin, hyaline, lanceolate, obtuse, nearly three-fourths as long as the flowering glume. Grain lanceolate, about 1.5 mm. long.

Type specimen collected on Sierra Madre Mountains, State of Zacatecas, 2373 J. N. Rose, August 18, 1897.

Agrostis setifolia Fourn. Mex. Pl. **2**: 97 (1881).

Sierra de San Felipe, altitude 3,075 m., State of Oaxaca, 922 C. L. Smith, September 25, 1894.

Agrostis verticillata Vill. Prosp. 16 (1779).

Durango, State of Durango, 179 E. Palmer, June, 1896; Nombre de Dios, 95 E. Palmer, April, 1896; Saltillo, State of Coahuila, 806 E. Palmer, September, 1898, in low, wet places along ditches.

Agrostis virletii Fourn. Mex. Pl. **2**: 96 (1881).

Durango, State of Durango, 190 E. Palmer, June, 1896, very abundant in low, wet places in alkali bottoms.

FIG. 5.—*Agrostis rosei* Scrib. & Merrill: *a*, a spikelet; *b*, the awned flowering glume and palea; *c*, the grain.

***Avena micrantha** Scribn. U. S. Dept. Agr. Div. Agros. Cir. **19**: 3, *fig. 1* (January 1, 1900). (Fig. 6.)

A very slender, densely cæspitose, upright perennial, 2.5 to 3.5 dm. high, with soft leaves 6 to 15 cm. long, 1 to 2 mm. wide, ligules 5 to 6 mm. long, and loosely flowered simple panicles 5 to 7 cm. long. Sheaths glabrous; leaves pubescent above, smooth beneath, becoming involute when dry; branches of the panicle capillary, spreading or ascending, 1 to 3 flowered, the longer lower branches 1 to 3 cm. long; empty glumes unequal, lanceolate, the first about 8 mm. long, 1-nerved, the second about as long as the flowering glume, 3-nerved near the base, thin-membranous and abruptly pointed; flowering glumes glabrous, 5-nerved, rounded

on the back, 2-toothed at the apex, the teeth awn-like; callus rather densely bearded, hairs stiff, the longer ones 3 to 4 mm. long; awn arising below the apex of the flowering glume, slender, geniculate, twisted below the geniculation, about 17 mm. long. Palea as long as the flowering glume, rather rigid, margins rounded, inflexed, apex subhyaline, the two nerves extending into subulate, awn-like teeth.

Cool, mossy cliffs, Sierra de Tepixtlan, near Cuernavaca, State of Morelos, altitude 2,300 m., 8018 C. G. Pringle, February 5, 1899.

***Avena stipoides** Scribn. U. S. Dept. Agr. Div. Agros. Cir. **19:** 4 (January, 1900).

A very slender, erect, somewhat wiry perennial, 5 to 6 dm. high, with linear, erect leaves and loosely few-flowered, simple panicles 5 to 10 cm. long. Sheaths shorter than the internodes, very minutely strigose-pubescent; ligule 5 to 8 mm. long, hyaline; leaves involute-setaceous, at least when dry, 1 to 2.5 mm. wide, 1 to 2 dm. long, scabrous. Spikelets about 12 mm. long, exclusive of the awn; empty glumes unequal, thin, scarious, 1-nerved, acute, the first about 4 mm. long, the second 5.5 mm. long; flowering glume 11 mm. long, 5-nerved, slightly roughened on the nerves above, 2-toothed at the apex, teeth awn-like, awned on the back below the 2-toothed apex; awn geniculate, twisted below, attached about two-thirds above the base, 12 to 14 mm. long. Palea equaling the glume, the two nerves extending into subulate, awn-like teeth. Callus hairs 1 to 2 mm. long.

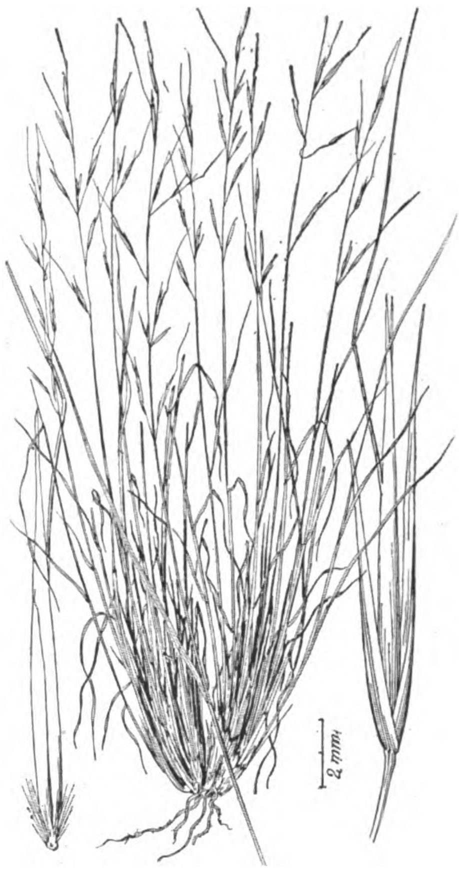

Fig. 6.—*Avena micrantha* Scribn.

Sierra de San Felipe, State of Oaxaca, altitude 3,130 m., 4905 C. G. Pringle, September 19, 1894; 923 C. L. Smith, August 28, 1894. Distributed as *Muhlenbergia stipoides* Trin.

This grass is closely allied to *Avena micrantha*, 8018 C. G. Pringle, but is at once distinguished by its shorter empty glumes.

The strictly 1-flowered spikelets of this and the last species is a character which would lead one to place these grasses in the tribe *Agrostideæ;* but the densely hairy callus and rather rigid 5-nerved flowering glume, which is deeply 2-toothed at the apex, and the dorsal, geniculate, and twisted awn formed by the union of three of the nerves suggest relationship with *Avena*, as does the character of the empty glumes, and these species are tentatively placed in that genus.

TRISTACHYA AVENACEA (Presl) Scribn. & Merrill, n. comb. (*Monopogon avenaceus* Presl, Rel. Haenk. **1:** 335, *t. 44* (1830); *Tristachya mexicana* Kunth, Enum. Pl. **1:** 308 (1833).)

This plant has been referred to the South American *Tristachya leiostachya* Nees, from which it is readily distinguished by its more slender habit, plane, not involute leaves, and shorter spikelets and awns. The spikelets of *T. leiostachya* are 5 cm. long and the awns are about 12 cm. long. In *T. avenacea* the spikelets are from 2 to 3.5 cm. long and the awns do not exceed 6 cm. in length.

Near Santa Teresa, Sierra Madre Mountains, Territorio de Tepic, 2229 J. N. Rose, August 13, 1897.

TRISTACHYA LAXA Scribn. & Merrill, sp. nov. (Fig. 7.)

A stout, erect perennial, 15 to 20 dm. high, with long leaves, scabrous spikelets, and very lax panicles 4 to 5 dm. in length. Culms rigid, glabrous, about 1 cm. in diameter at the base; nodes smooth; sheaths striate, the lower ones numerous, imbricate, sparingly pubescent, the upper scabrous; ligule a dense ciliate fringe of soft hairs about 2 mm. long; leaf-blades involute or folded below, plane above, 4 to 7 dm. long, 5 to 10 mm. wide, glabrous beneath, scabrous on the upper surface and margins, somewhat bearded at the throat. Panicle very lax, the lower portion somewhat inclosed by the upper sheath; rachis smooth; branches alternate, the lower ones in clusters of twos at each node, solitary above, somewhat pubescent at the axils, very slender, the lower ones 2 dm. long, simple or once branched above the middle. Spikelets short-pedicellate, in clusters of threes at the end of the branches, 1.5 to 2 cm. long; empty glumes purple, 3-nerved, acute, the first slightly shorter than the second, strongly scabrous on the keel and lateral nerves, slightly scabrous on the margins; third glume nearly equaling and inclosed by the first glume, 5-nerved, subtending a hyaline palea nearly its own length and a staminate flower, flowering glume 8 to 9 mm. long, 9-nerved, pubescent throughout with spreading white hairs, apex cleft, forming 2 acute teeth about 2 mm. long and bearing between them a scabrous, geniculate awn 2 to 2.5 cm. in length, which is twisted below the geniculation, straight above.

FIG. 7.—*Tristachya laxa* Scribn. & Merrill: *a*, a group of spikelets; *b*, a single floret.

Type collected in the State of Durango, 2334 J. N. Rose, August 16, 1897. Readily distinguished from the other species in this genus by its stout culms, lax panicles, long capillary branches, scabrous empty glumes, and long sterile palea.

Microchloa indica (L. f.) Kuntze, Rev. Gen. Pl. **3**^{2}: 356 (1898). (*Nardus indica* L. f. Suppl. Pl. 105 (1781); *Microchloa setacea* R. Br. Prodr. Fl. Nov. Holl. **1**: 208 (1810).)

Durango, State of Durango, 532 E. Palmer, August, 1896.

Cynodon dactylon Pers. Syn. Pl. **1**: 85 (1805).

Saltillo, State of Coahuila, 254 E. Palmer, June, 1898; 814 E. Palmer, October, 1898.

CHLORIS CLANDESTINA Scribn. & Merrill, nom. nov. (*Gymnopogon longifolius* Fourn. Mex. Pl. **2**: 144 (1881); *Chloris longifolia* Vasey, Contr. U. S. Nat Herb. **1**: 284, *pl. 19* (1893), not Steud. Syn. Pl. Gram. 205 (1854).)

Topolobampo, State of Sinaloa, 238 E. Palmer, September, 1897, in small bunches under other plants in bottom lands.

Chloris elegans H. B. K. Nov. Gen. et Sp. Pl. **1**: 166 (1815).

Durango, State of Durango, 176 E. Palmer, June, 1896; 765 E. Palmer, October, 1896; near Colotlan, State of Jalisco, 3604 J. N. Rose, August 29, 1897; Colima, 140 E. Palmer, September, 1897; Topolobampo, State of Sinaloa, 245 E. Palmer, September, 1897; Parras, State of Coahuila, 448 E. Palmer, October, 1898; on the road from Casas Grandes to Sabinal, State of Chihuahua, 6354 E. W. Nelson, September 4–5, 1899, in open bottom lands, among cacti and other plants.

Chloris submutica H. B. K. Nov. Gen. et Sp. Pl. **1**: 167, *t. 50* (1815).

Durango, State of Durango, 181 E. Palmer, June, 1896; in the Sierra Madre Mountains, near Santa Teresa, Territorio de Tepic, 2143 J. N. Rose, August 9, 1897; Saltillo, State of Coahuila, 390 E. Palmer, September, 1898.

Bouteloua aristidoides (H. B. K.) Griseb. Fl. Brit. W. Ind. 537 (1864). (*Dinebra aristidoides* H. B. K. Nov. Gen. et Sp. Pl. **1**: 171 (1815).)

Durango, State of Durango, 717 E. Palmer, September, 1896; near San Juan Capistrano, State of Zacatecas, 2490 J. N. Rose, August 23, 1897; Topolobampo, State of Sinaloa, 237 E. Palmer, September, 1897; Torreon, State of Coahuila; 513 E. Palmer, October, 1898; near Casas Grandes, State of Chihuahua, 6329 E. W. Nelson, August 30, 1899.

Bouteloua bromoides (H. B. K.) Lag. Gen. et Sp. Nov. 5 (1816). (*Dinebra bromoides* H. B. K. Nov. Gen. et Sp. Pl. **1**: 172. *t. 51* (1815).)

Between Monte Escobedo and Colotlan, State of Jalisco, 2672 J. N. Rose, August 28, 1897; near Pachico, State of Chihuahua, 6258 E. W. Nelson, August 22–24, 1899; Sierra Madre Mountains, 10 miles north of Pachico, 6305 E. W. Nelson, August 25, 1899.

Bouteloua curtipendula (Michx.) Torr. in Emory, Notes Mil. Recon. 153 (1848). (*Chloris curtipendula* Michx. Fl. Bor. Am. **1**: 59 (1803); *B. racemosa* Lag. Varied. Cienc. Lit. Art. **2**^{4}: 14 (1805).)

Monte Alban, near Oaxaca, State of Oaxaca, 958 C. L. Smith, September 5, 1894; Bolaños, State of Jalisco, 2929 J. N. Rose, September 10–19, 1897; Durango, State of Durango, 194 E. Palmer, June, 1896; Saltillo, State of Coahuila, 407 E. Palmer, September, 1898; below Pachico, State of Chihuahua, 6247 E. W. Nelson, August 22–24, 1899.

Bouteloua havardi Vasey, Proc. Am. Acad. **18**: 179 (1883).

Durango, State of Durango, 546 E. Palmer, August, 1896; near Huejuquilla, State of Jalisco, 2532 J. N. Rose, August 24, 1897; near Plateado, State of Zacatecas, 2782 J. N. Rose, September 3, 1897.

Bouteloua hirsuta Lag. Varied. Cienc. Lit. Art. **2**^{4}: 141 (1805).

Durango, State of Durango, 870 E. Palmer, November, 1896; between Concepcion and Acaponeta, 1904 J. N. Rose, July 29, 1897; near Acaponeta, Territorio de Tepic, 3293 J. N. Rose, July 30, 1897; on the road between Huejuquilla and Mesquitec,

State of Jalisco, 2586 J. N. Rose, August 25, 1897; Saltillo, State of Coahuila, 405 E. Palmer, September, 1898; near Pachico, State of Chihuahua, 6246 E. W. Nelson, August 22–24, 1899.

Bouteloua oligostachya Torr. in A. Gray, Man. Bot. ed. 2, 553 (1856).

Durango, State of Durango, 545 E. Palmer, August, 1896; Saltillo, State of Coahuila, 399, **403**, **406** E. Palmer, September, 1898; near Casas Grandes, State of Chihuahua, **6327** E. W. Nelson, August 30, 1899.

Bouteloua polystachya Torr. Pac. R. R. Rept. **5**[2]: 366, *t. 10* (1847).

San Antonio Valley, State of Oaxaca, 957 C. L. Smith, September 1, 1894; Durango, State of Durango, 714 E. Palmer, September, 1896; Torreon, State of Coahuila, 514 E. Palmer, October, 1898; Saltillo, 401 E. Palmer, September, 1898.

Bouteloua ramosa Scribn. in Vasey, U. S. Dept. Agr. Div. Bot. Bul. **12**[1]: 44, *pl. 44* (1891).

Saltillo, State of Coahuila, 404 E. Palmer, September, 1898, in close tufts in low places on the mesa.

BOUTELOUA REPENS (H. B. K.) Scribn. & Merrill, n. comb. (*Dinebra repens* H. B. K. Nov. Gen. et Sp. Pl. **1**: 172, *t. 52* (1815).)

Durango, State of Durango, 547 E. Palmer, August, 1896.

Bouteloua tenuis Griseb. in Goett. Abh. **24**: 303 (1879).

Durango, State of Durango, 712 E. Palmer, September, 1896; Saltillo, State of Coahuila, 397, 378 E. Palmer, September, 1898; Pedrigal, Valley of Mexico, Federal District, 6450 C. G. Pringle, August 20, 1896. This grass grows so abundantly on the mesquite plains that it gives them the appearance of a lawn.

Bouteloua trifida Thurb. Proc. Am. Acad. **18**: 177 (1883).

Saltillo, State of Coahuila, 402 E. Palmer, September, 1898.

Pentarrhaphis fournierana Hack. & Scribn. Bul. Torr. Bot. Club, **17**: 232, *pl. 107* (1890).

Durango, State of Durango, 382 E. Palmer, July, 1896; between Acaponeta and Rosario, J. N. Rose, no number, July 6, 1897; between Rosario and Colomas, State of Sinaloa, 1621 J. N. Rose, July 12, 1897; near Tequila, State of Jalisco, 4775 Rose and Hough, July 5–6, 1899.

Eleusine indica Gaertn. Fruct. et Sem. **1**: 8 (1788).

Coatzacoalcos, isthmus of Tehuantepec, State of Vera Cruz, 1050 C. L. Smith, March 16, 1895.

Dactyloctenium ægyptium (L.) Willd. Enum. 1029 (1809). (*Cynosurus ægyptius* L. Sp. Pl. 72 (1753).)

Durango, State of Durango, 735 E. Palmer, September, 1896; between Rosario and Acaponeta, State of Sinaloa, 1877 J. N. Rose, July 25, 1897; Coatzacoalcos, isthmus of Tehuantepec, State of Vera Cruz, 1055 C. L. Smith, February 1, 1895; Colima, 10, 11, 167, 168 E. Palmer, July, 1897; Topolobampo, State of Sinaloa, 246 E. Palmer, September, 1897.

LEPTOCHLOA AQUATICA Scribn. & Merrill, sp. nov.

An erect, glabrous, branching perennial about 7 dm. high, with smooth culms, flat leaves, and obtuse flowering glumes. Culms much branched below, striate, cylindrical, rooting at the lower nodes; nodes brown, smooth; sheaths loose, longer than the internodes, the lower ones compressed, smooth or minutely roughened; ligule 1 to 2 mm. long, fimbriate; leaf-blades thin, linear-lanceolate, 10 to 20 cm. long, 5 to 8 mm. wide, slightly scabrous or nearly smooth on both sides, scabrous on the margins. Panicles 10 to 12 cm. long, green; common axis smooth or slightly roughened above, striate; branches erect, 2 to 5 cm. long, alternate, scabrous, floriferous throughout. Spikelets ovate-lanceolate, rather loosely 3 to 4 flowered, about 5 mm. long, on short scabrous pedicels about 1 mm. in length; empty glumes very unequal, 1-nerved, slightly scabrous on the keels, the first about 1 mm. long, narrowly triangular-lanceolate, acute,

the second 2 mm. long, broad, rhomboidal, triangular-acute at the apex; flowering glumes about 3 mm. long, broadly ovate (when spread), obtuse, awnless, glabrous except on the scabrous keel, 3-nerved, the middle nerve prominent, percurrent, the lateral ones marginal, extending about two-thirds the length of the glume, slightly pilose. Palea equaling the glumes, lanceolate-spatulate, truncate, and slightly denticulate at the apex, sparingly pilose on the margins below.

Type specimen collected in shallow water near Cuernavaca, State of Morelos, altitude 1,700 m., 6664 C. G. Pringle, August 22, 1897.

In habit very much resembling *Leptochloa halei*, but at once distinguished from that species by its more unequal empty glumes and obtuse awnless flowering glumes.

Leptochloa dubia Nees, Syllog. Ratisb. **1**: 4 (1824).

Santiago Papasquiaro, State of Durango, 468 E. Palmer, August, 1896; Durango, 530 E. Palmer, August, 1896; Saltillo, State of Coahuila, 381, 382 E. Palmer, September, 1898.

LEPTOCHLOA DUBIA PRINGLEANA (Kuntze) Scribn. & Merrill, n. comb. (*Diplachne dubia pringleana* Kuntze, Rev. Gen. Pl. **3**: 349 (1898).)

Hills and plains near Chihuahua, 422 C. G. Pringle, August, 1885.

Leptochloa fascicularis (Lam.) A. Gray, Man. Bot. ed. 5, 623 (1867).

Durango, State of Durango, 254 E. Palmer, June, 1896; Torreon, State of Coahuila, 503 E. Palmer, October, 1898, rich, moist ground, along ditches subject to overflow.

Leptochloa filiformis Presl, Rel. Haenk. **1**: 288 (1830).

Topolobampo, State of Sinaloa, 248 E. Palmer, September, 1897, common on bottom lands.

LEPTOCHLOA HALEI (Nash) Scribn. & Merrill, n. comb. (*Diplachne halei* Nash, Bul. N. Y. Bot. Gard. **1**: 292 (1899).

Foothills between Acaponeta and Pedro Paulo, Territorio de Tepic, 1930 J. N. Rose, August 2, 1897.

This species can scarcely be distinct from *Leptochloa floribunda*, Doell,[1] although the details as drawn in the plate representing that species do not agree with our specimens of *Leptochloa halei* nor with those of authentic material of *Leptochloa floribunda*. There is in the U. S. National Herbarium one sheet of Hale's Louisiana collection and two sheets from the Herbarium Hookerianum, the latter labelled "*Leptochloa floribunda* Doell. Ad ripas fluminis Amazonum inter Santarem et Barra de Rio Negro, Coll. R. Spruce, October, 1850," and also in what is evidently Bentham's handwriting "Texas, Drummond, No. 322 ex herb. T. C. D(rummond) is identical with this." No. 322 Drummond is cited by Nash as the type of *Diplachne halei*.

Doell cited as the type of his species "ad ripas fluminis Amazonum inter Manos et Santarem (Spruce)," and although the material in the National Herbarium may not be of the collection on which *Leptochloa floribunda* is based, there can be no doubt but that it is typical.

A careful comparison of the specimens collected by Hale in Louisiana and those collected by Spruce in Brazil proves conclusively that they are the same, and the only hesitation we have in not referring *Diplachne halei* to *Leptochloa floribunda* is the fact that details of the latter as drawn by Doell differ somewhat from both our North and South American material.

Leptochloa mucronata Kunth, Rev. Gram. **1**: 91 (1835).

Rosario, State of Sinaloa, 1542 J. N. Rose, July 7, 1897; San Jose de Guaymas, 270 E. Palmer, October 14, 1897; Colima, 22 E. Palmer, July, 1897.

Pappophorum apertum Munro, Bul. Torr. Bot. Club, **9**: 148 (1882).

Saltillo, State of Coahuila, 256 E. Palmer, June, 1898; 377 E. Palmer, September, 1898.

[1] Mart. Fl. Bras. **3**[2]: 89, *pl. 26* (1878).

Pappophorum wrightii Wats. Proc. Am. Acad. **18:** 178 (1882–83).

Durango, State of Durango, 721 E. Palmer, September, 1896; Saltillo, State of Coahuila, 395 E. Palmer, September, 1898.

Cottea pappophoroides Kunth, Rev. Gram. **1:** 84, 281, *t. 52* (1835).

Bolanos, State of Jalisco, 2914 J. N. Rose, September 10–19, 1897.

Cathestecum prostratum Presl, Rel. Haenk. **1:** 295, *t. 42* (1830).

San Antonio Valley, State of Oaxaca, 958 C. L. Smith, 1894; Colima, 12 E. Palmer, July, 1897; between Huejuquilla and Mesquitec, State of Jalisco, 2582 J. N. Rose, August 25, 1897; a close compact-growing grass with long runners, forming a fine, close sod; spots of considerable size are found covered with it.

Cathestecum sp.

Monte Alban, State of Oaxaca, 950 C. L. Smith, 1894. This specimen is doubtfully referred to *Cathestecum*, but is very distinct from both *C. prostratum* Presl and *C. erectum* Vasey and Hack, and is seemingly intermediate between the genera *Cathestecum* and *Pentarrhaphis*. The material in the National Herbarium is in a too unsatisfactory condition for accurate determination.

Scleropogon brevifolius Philippi, Sert. Mendoc. **2:** 48 (1871).

Saltillo, State of Coahuila, 386 E. Palmer, September, 1898, common on dry hills.

Monanthochloe littoralis Engelm. Trans. Acad. Sci. St. Louis, **1:** 436. *tt. 13, 14* (1859).

Altata, State of Sinaloa, 1370 J. N. Rose, June 15, 1897.

Munroa squarrosa (Nutt.) Torr. Pac. R. R. Rept. **4**^{5}: 158 (1857). (*Crypsis squarrosa* Nutt. Gen. **1:** 49 (1818).)

Colonia Diaz, State of Chihuahua, 6440 E. W. Nelson, September 20–21, 1899.

Triodia acuminata Benth. in Vasey, U. S. Dept. Agr. Div. Bot. Spec. Rept. **63:** 35 (1883).

Saltillo, State of Coahuila, 262 E. Palmer, June, 1898, 813 E. Palmer, September, 1898, in dense tufts on dry rocky hills.

Triodia avenacea H. B. K. Nov. Gen. et Sp. Pl. **1:** 156, *t. 48* (1815).

Saltillo, State of Coahuila, 414 E. Palmer, September, 1898, on rocky hillsides, forming dense tufts.

Triodia pulchella H. B. K. Nov. Gen. et Sp. Pl. **1:** 155, *t. 47* (1815).

Durango, State of Durango, 740 E. Palmer, September, 1896; Saltillo, State of Coahuila, 257 E. Palmer, June, 1898, 413 E. Palmer, September, 1898; near Lake Santa Maria, State of Chihuahua, 6414 E. W. Nelson, September 7, 1899.

Eragrostis ciliaris (L.) Link, Hort. Berol. **1:** 192 (1827).

Acaponeta, Territorio de Tepic, 3135 J. N. Rose, June 23–30, 1897.

Eragrostis glomerata (Walt.) Dewey, Contr. U. S. Nat. Herb. **2:** 543 (1894). (*Poa glomerata* Walt. Fl. Car. 80 (1788); *Eragrostis conferta* Trin.) Near Cuernavaca, State of Morelos, 6605 C. G. Pringle, 1896.

Eragrostis limbata Fourn. Mex. Pl. **2:** 116 (1881).

On the road from Casas Grandes to Sabinal, State of Chihuahua, altitude 1,700 m., 6353 E. W. Nelson, September 4–5, 1899; plains near Sierra En Media, State of Chihuahua, 6466 E. W. Nelson, September 24–26, 1899.

Eragrostis lugens Nees, Agrost. Bras. 507 (1829).

Durango, State of Durango, 727 E. Palmer, September, 1896; Saltillo, State of Coahuila, 408 E. Palmer, September, 1898, a showy grass, growing in rich soil where stock could not reach it.

Eragrostis major Host, Gram. **4:** *t. 24* (1809).

Durango, State of Durango, 720 E. Palmer, September, 1896; Saltillo, State of Coahuila, 389 E. Palmer, September, 1898, in rich soil about dwellings, in gardens, etc.

Eragrostis mexicana Link, Hort. Berol. **1:** 190 (1827).

Durango, State of Durango, 531, 768, 875, E. Palmer, June–November, 1896; Colima, 20 E. Palmer, July, 1897; Torreon, State of Coahuila, 510 E. Palmer, October, 1898; Saltillo, 376, 409, 411 E. Palmer, September, 1898.

Eragrostis neo-mexicana Vasey, in Beal, Grasses N. A. **2:** 485 (1896).

Near Colotlan, State of Jalisco, 3605 J. N. Rose, August 29, 1897; Saltillo, State o Coahuila, 410, 412 E. Palmer, September, 1898; Sierra Madre Mountains, north of Pachico, State of Chihuahua, 6300 E. W. Nelson, August 25, 1899.

Eragrostis panamensis Presl, Rel. Haenk. **1:** 277 (1830).

Coatzacoalcos, Isthmus of Tehuantepec, State of Vera Cruz, 1051 C. L. Smith, February, 1895, a robust form, distributed as *Eragrostis major* Host.

Eragrostis pilosa (L.) Beauv. Agrost. 71 (1812).

Durango, State of Durango, 726 E. Palmer, September, 1896; Saltillo, State of Coahuila, 811 E. Palmer, September, 1898.

Eragrostis plumosa Link, Hort. Berol. **1:** 192 (1827).

Colima, 15 E. Palmer, July, 1897, along roadsides, shady ravines, and in gardens.

Eragrostis purshii Schrad. Linnæa, **12:** 451 (1838).

Durango, State of Durango, 177, 183, 534, 723, 764, 869 E. Palmer, June–October, 1896; Rosario, State of Sinaloa, 1544, 1545 J. N. Rose, July 7, 1897, 1847 J. N. Rose, July 26, 1897; Guaymas, State of Sonora, 1281 J. N. Rose, June 5–11, 1897; Bolanos, State of Jalisco, 3699 J. N. Rose, September 10–19, 1897; between Agnacata and Dolores, Territorio de Tepic, 2016 J. N. Rose, August 6, 1897; Colima, 13 E. Palmer, 1897; Topolobampo, State of Sinaloa, 240 E. Palmer, September, 1897; Saltillo, State of Coahuila, 812 E. Palmer, September, 1898.

Eragrostis sessilispica Buckl. Proc. Acad. Nat. Sci. Phila. **1862:** 97 (1862).

Near Lake Santa Maria, State of Chihuahua, 6413 E. W. Nelson, September 7, 1899.

Eatonia obtusata A. Gray, in S. Wats. Bot. Calif. **2:** 302 (1880).

Durango, State of Durango, 255 E. Palmer, June, 1896.

Koeleria cristata (L.) Pers. Syn. **1:** 97 (1805). (*Aira cristata* L. Sp. Pl. 63 (1753).)

Near Colonia Garcia, Sierra Madre Mountains, State of Chihuahua, 6198 E. W. Nelson, August 1, 1899.

Distichlis prostrata (H. B. K.) Desv. Gram. Chil. 398 (1853). (*Poa prostrata* H. B. K. Nov. Gen. et Sp. Pl. **1:** 157 (1815).)

Durango, State of Durango, 182, 385(?), 388 E. Palmer, 1898, common in damp, alkali meadows.

Distichlis spicata (L.) Greene, Bul. Calif. Acad. Sci. **2:** 415 (1887). (*Uniola spicata* L. Sp. Pl. 71 (1753).)

Altata, State of Sinaloa, 1367 J. N. Rose, June 15, 1897; San Jose de Guaymas, 270 E. Palmer, October 14, 1897; near Lake Santa Maria, State of Chihuahua, 6461 E. W. Nelson, September 7, 1899. This grass is planted along ditches in sandy soil to prevent banks from washing.

Distichlis texana (Vasey) Scribn. U. S. Dept. Agr. Div. Agros. Bul. **17:** 236, *fig. 532* (1899). (*Poa texana* Vasey. Contr. U. S. Nat. Herb. **1:** 60 (1890); *Sieglingia wrightii* Vasey, Contr. U. S. Nat. Herb. **1:** 269 (1893).)

Torreon, State of Coahuila, 507 E. Palmer, October, 1898, growing on sandy banks of the Nassus River.

Poa annua L. Sp. Pl. 68 (1753).

Nombre de Dios, State of Durango, 97 E. Palmer, April, 1896; Saltillo, State of Coahuila, 6 E. Palmer, April, 1899, about dwellings.

Poa infirma H. B. K. Nov. Gen. et Sp. Pl. **1:** 158 (1815).

Near Plateado, State of Zacatecas, 2712 J. N. Rose, September 1, 1897.

* **Poa pratensis** L. Sp. Pl. 67 (1753).

Mountains near Jalapa, State of Vera Cruz; altitude, 1,750 m.; 7880 C. G. Pringle, April–May, 1899.

Graphephorum altijugum Fourn. Bul. Soc. Bot. Fr. **24:** 182 (1877).

Sierra de San Felipe, State of Oaxaca, 941 C. L. Smith, 1894.

Festuca amplissima Rupr. Bul. Acad. Brux. **9**^{2}: 236 (1842).

Sierra de San Felipe, State of Oaxaca, 924 C. L. Smith, September, 1894; Durango, State of Durango, 2358 J. N. Rose, August 16, 1897, small form.

Bromus carinatus arizonicus Shear, U. S. Dept. Agr. Div. Agros. Bul. **23**: 61 (1900).

Sierra Madre Mountains, near Santa Teresa, Territorio de Tepic, 2138 J. N. Rose, August 9, 1897.

Bromus ciliatus L. Sp. Pl. 76 (1753).

Sierra de San Felipe, altitude 3,075 m., State of Oaxaca, 925 C. L. Smith, September, 1894.

Bromus compressus Lag. Elench. 4 (1816).

Saltillo, State of Coahuila, 5 E. Palmer, April, 1898; 366 E. Palmer, September, 1898, in alfalfa, along irrigating ditches.

Bromus laciniatus Beal, Grasses N. A. **2**: 615 (1896).

Sierra de San Felipe, State of Oaxaca, 942 C. L. Smith, September, 1894.

Bromus porteri frondosus Shear, U. S. Dept. Agr. Div. Agros. Bul. **23**: 37 (1900).

Near Plateado, State of Zacatecas, 2727 J. N. Rose, September 1, 1897.

BROMUS SCHAFFNERI (Fourn.) Scribn. & Merrill, n. comb. (*Bromus hookeri schaffneri* Fourn. Mex. Pl. **2**: 127 (1881).)

Durango, State of Durango, 171 E. Palmer, June, 1896, 743 E. Palmer, September, 1896.

Agropyron arizonicum Scribn. & Smith, U. S. Dept. Agr. Div. Agros. Bul. **4**: 27 (1897).

Base of Sierra Madre Mountains, State of Chihuahua, near the border of Mexico, 6495 E. W. Nelson, September 29, 1899.

Elymus brachystachys Scribn. & Ball. (p. 47).

Saltillo, State of Coahuila, 260 E. Palmer, June, 1898.

ELYMUS PRINGLEI Scribn. & Merrill, sp. nov.

A slender, erect, cæspitose perennial, 6 to 9 dm. high, with slender culms, linear or linear-lanceolate leaves and rather loosely flowered, pale green panicles 4 to 12 cm. long. Culms very slender, glabrous, often somewhat geniculate below; nodes smooth; sheaths smooth, striate, mostly shorter than the internodes; ligule hyaline, obtuse, slightly toothed, about 1 mm. long; leaf-blades 10 to 20 cm. long, 3 to 8 mm. wide, scabrous on both sides. Rachis somewhat compressed, slightly scabrous, somewhat strigose above, the internodes shorter than the spikelets. Spikelets 2 at each node, 3 to 4 flowered, about 10 mm. long, exclusive of the awns; empty glumes subequal, scabrous, subulate-setaceous, about 22 mm. long; flowering glumes lanceolate, acuminate, 5-nerved, strigose-pubescent, with rather short, stiff hairs, especially above, bearing a straight, slender, scabrous awn 8 to 15 mm. long. Palea lanceolate, obtuse, strongly serrulate-scabrous on the margins above, 7 to 8 mm. long.

Type specimen collected in wet soil in a valley near Tula, State of Hidalgo, altitude 2,200 m., 6637 C. G. Pringle, June 8, 1897, distributed as *Elymus botteri;* 7165 C. G. Pringle, same locality, October 24, 1896, belongs here.

This species differs from *E. interruptus* Buckl. in its slender habit, narrower, setaceous empty glumes, and strongly strigose-pubescent flowering glumes.

***Sitanion brevifolium** J. G. Smith, U. S. Dept. Agr. Div. Agros. Bul. **18**: 17 (1899).

Cerro Ventoso, above Pachuca, State of Hidalgo, altitude 2,600 m., 6944 C. G. Pringle, August 18, 1899.

Arundinaria longifolia Fourn. Mex. Pl. **2**: 131 (1881).

Between Pedro Paulo and San Blascito, Territorio de Tepic, 3344 J. N. Rose, August 4, 1897; near Huasemote, State of Durango, 3494 J. N. Rose, August 15, 1897.

II.—NOTES ON PANICUM NITIDUM LAM., PANICUM SCOPARIUM LAM., AND PANICUM PUBESCENS LAM.

By F. LAMSON-SCRIBNER and ELMER D. MERRILL.

While in Paris in March and April, 1900, Mr. A. H. Baldwin, an artist of the Department, made careful drawings and notes on some of Michaux's and Lamarck's types in the Herbarium of the Muséum d'Histoire Naturelle de Paris, and among them were found the types or at least typical material of *Panicum nitidum*, *Panicum pubescens*, and *Panicum scoparium*. As none of these species have been understood by American authors, the following notes on the results of studying these types will clear up the existing confusion regarding the identity of these species. F. L.-S.

PANICUM NITIDUM Lam.

Lamarck first characterized *Panicum nitidum* in his Tabl. Encycl. **1**: 172 (1791), as follows:

"899. *Panicum nitidum.*

"P. panicula ramosa subviolacea, glumis obtusis striatis, semine nitido.

"E Carolinia Com. D. Fraser."

Later in his Encycl. **4**: 738 (err. typ. 748) (1797), he more fully characterized the species with the following description:

"*Panic luisant; Panicum nitidum.* Illustr. no. 899.

"Panicum panicula ramosa subviolacea, glumis obtusis striatis hispidulis, semine nitido.

"Sa tige est à peine hautre d'un pied, glabre, articulée, feuillée. Les feuilles sont larges de deux ou trois lignes, glabres, excepté à l'entrée de leur gaîne, qui est longue et striée. La panicule est médiocre, rameuse, longue de deux à trois pouces, et teinte d'un violet-brun, ainsi que les articulations de la tige. Les fleurs sons ovales, obtuses, mutiques, striées, légèrement hispides, d'un vert teint de violet-brun. Les graines sont très luisantes.

"Cette graminée croît dans la Caroline, où elle a été recueillie par Fraser, naturaliste anglois (v. s.). Le citoyen Michaux l'a aussi trouvée dans diferentes parties de l'Amérique septentrionale; et il en a recueilli dans la Pensylvanie une variété à fleurs plus petites et à feuilles fort étroites."[1]

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[1] The culm is scarcely a foot high, glabrous, articulate, leafy. The leaves are 2 or 3 lines wide, glabrous, except at the beginning of the sheath, which is long and striate. The panicle is medium, branching, 2 to 3 inches long and of a violet-brown color, as are also the articulations of the stem. The flowers are oval, obtuse, muticous, striate, slightly hispid, green tinted with violet-brown. The grain is very shining.

This grass grows in Carolina, where it was collected by Fraser, an English naturalist (v. s.). Michaux also found it in different parts of North America, and he collected in Pennsylvania a variety with smaller flowers and very narrow leaves.

Michaux, Fl. Bor. Am. **1**: 49 (1843), gives some additional characters for this species in the following description:

"*Panicum nitidum* Lam. P. glabrum, vaginarum collo barbato culmo gracili, simplici, erecto; foliis paucissimis, remotis, lanceolato-linearibus; panicula capillari, confertiuscula, composite ramosa, glabra; floribus pusillis, obtuse ovatis, minutissime puberulis; valvula extima vix perceptibili.

"Hab. in Pennsylvania et Carolina."

Michaux's plant (fig. 8) in the Herbarium of the Paris Museum of Natural History bears the following label: "Herb. Mus. Paris, Herbier de l'Amérique septentrionale d'André Michaux: Panicum nitidum Lam. Hab. en Pensylvanie, Carolina."

FIG. 8.—*Panicum nitidum* Michx., drawn from specimen in the Herbarium of the Muséum d'Histoire Naturelle de Paris by A. H. Baldwin.

While Lamarck first cites Fraser's plant, yet, judging from his description and from the fact that he evidently had both Fraser's and Michaux's plants in his possession at the time he wrote the longer description, there can be little doubt as to their identity.

We believe that Michaux's plant should be considered as typical *Panicum nitidum* Lam., at least until positive proof is given that it is different from Fraser's plant cited by Lamarck.

Panicum nitidum has never been understood by American authors, and many forms have been referred to it by different authorities. Unfortunately no spikelets remain on Michaux's plant, but a careful study of the above descriptions and the drawing of Michaux's plant leads us to consider *Panicum nitidum* as follows:

Panicum nitidum Lam. Tabl. Encycl. **1**: 172 (1791); Encycl. **4**: 738 (err. typ. 748) (1797); *Panicum* No. 37 (sine nomine) Muhl. Descr. 125 (1817); *Panicum spretum* Schultes, Mant. **2**: 248 (1824); *Panicum nitidum* forma *densiflorum* Rand. & Redfield, Fl. Mt. Desert Isl. 174 (1894); *Panicum eatoni* Nash, Bull. Torr. Bot. Club, **25**: 84 (1898); *Panicum paucipilum* Nash, ibid. **26**: 573 (1899).

A glabrous, tufted perennial 6 to 10 dm. high, with erect, narrowly lanceolate leaves, and exserted, contracted panicles, bearing numerous, small, purplish, pubescent

spikelets. Culms at first simple, becoming dichotomously branched, generally purplish; nodes smooth; sheaths much shorter than the internodes, glabrous, striate, usually slightly ciliate on the margins above; ligule a dense ring of hairs about 2 mm. long; leaf-blades 5 to 10 cm. long, 3 to 10 mm. wide, acuminate, glabrous, or with few papillate hairs at the base. Panicle finally long-exserted, generally contracted, 5 to 13 cm. long; rachis glabrous; branches erect or ascending. Spikelets ovate, 1.4 to 1.6 mm. long; first glume small, one-fourth to one-third as long as the spikelet, glabrous, 1-nerved; second and third glumes

FIG. 9.—*Panicum catoni* Nash: *a, b, c,* spikelets; *d,* anterior view of third glume, showing small palea *e,* flowering glume, dorsal view; *f,* the same, anterior view, showing palea.

pubescent with spreading hairs, often densely so, 7-nerved; flowering glume about 1.3 mm. long.

TYPE LOCALITY.—Carolina and Pennsylvania. Type specimen in the Herbarium of the Paris Museum of Natural History.

GENERAL DISTRIBUTION.—In wet soil, especially near the coast, Maine to Mississippi, and Texas. May to September.

SPECIMENS EXAMINED.—*Maine:* Shore of Chase's Pond, York, 510 M. L. Fernald, 1891. *Massachusetts:* Essex County, W. P. Conant, 1891; Stoneham, 320, 336, 349 W.

P. Rich, 1894. *Rhode Island:* Johnston, J. W. Congdon, 1871. *Connecticut:* Waterford, 87 C. B. Graves, 1898. *New Jersey:* Atsion, 44 A. Commons, 1882; Gloucester County, 2 B. Heritage, 1897. *Mississippi:* Beauvoir, 4594 S. M. Tracy, 1898.

The habit of Michaux's plant, as shown by figure 8, is so characteristic and so closely resembles *Panicum eatoni* (Fig. 9) that we have no hesitation in referring *Panicum eatoni* to *Panicum nitidum*. *Panicum paucipilum* can not be satisfactorily distinguished from *P. eatoni*, either by the original descriptions or by comparison of typical material. The culms, sheaths, ligules, leaves, panicles, and spikelets are the same, and moreover both forms grow in moist places. Mr. Nash[1] states that *Panicum paucipilum* can be distinguished from *P. eatoni* by its *much smaller spikelets*, with the first glume glabrous and orbicular. The difference in measurements of the spikelets given by Mr. Nash is but 0.2 mm., and according to his original description and to specimens examined the first glume of *P. eatoni* is also glabrous! The type of *Panicum spretum* Schultes in Muhlenberg's Herbarium in the Academy of Nat. Sci. of Phil. is identical with *P. eatoni* Nash., the form with the dense contracted panicles.

The figure of *Panicum eatoni* above has shorter and broader leaves than in the type.

FIG. 10.—*Panicum nitidum octinodum* (Smith): *a, b,* spikelets; *c,* flowering glume.

PANICUM NITIDUM OCTINODUM (Smith) n. comb. (*Panicum octinodum* Smith, U. S. Dept. Agr. Div. Agros. Bul. **17**: 73, *fig. 369* (June 30, 1899); Scribn. & Smith, ibid. Cir. **16**: 5 (July 1, 1899).) (Fig. 10.)

A form which differs from typical *Panicum nitidum* only in having smooth spikelets.

TYPE LOCALITY.—Waller County, Texas.

GENERAL DISTRIBUTION.—In ponds and exsiccated swamps, Delaware and Texas.

SPECIMENS EXAMINED.—*Delaware:* Townsend, W. N. Canby, 1891; Cape Henlopen, 340 A. Commons, 1898. *Texas:* Waller County, F. W. Thurow, 1898 (type).

PANICUM SCOPARIUM Lam.

Panicum scoparium Lam. Encycl. **4**: 744 (1797!); Michx. Fl. Bor. Am. **1**: 49 (1803!), not of authors. (*Panicum pubescens* Lam. l. c. 748!; Michx. l. c.!, not of authors. *Panicum viscidum* Ell. Sk. Bot. S. C. and Ga. **1**: 123 (1817!). (Fig. 11.)

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[1] Bul. Torr. Bot. Club, **26**: 574 (1899).

A rather stout, erect or ascending and finally much-branched perennial, 3 to 14 dm. high, with the culms and sheaths usually densely pubescent with spreading or reflexed canescent hairs, and all parts somewhat viscid when fresh. Culms stout, often purplish; nodes bearded and with a glabrous ring immediately below; sheaths shorter than the internodes; ligule a dense ring of hairs about 2 mm. long; leaf-blades lanceolate, gradually tapering from near the middle to the very acute apex, subcordate at the base, softly pubescent on both sides, minutely scabrous on the margins, villous on the back at the point of union with the sheath, basal ones ovate, 5 to 10 cm. long, obtuse, those of the primary culm 12 to 25 cm. long, 10 to 20 mm. wide, those of the branches densely crowded and much smaller, 2 to 5 cm. long. Panicles 6 to 15 cm. long, ovate or subpyramidal; rachis more or less pubescent; branches compound to the base, flexuous; pedicels usually much longer than the spikelets. Spikelets 2 to 2.5 mm. long, ovate or ovate-lanceolate, acute; first glume minute, one-fourth as long as the spikelet or less, usually nerveless; second and third glumes strongly pubescent, 9-nerved. Below each of the nodes there is a smooth space about 4 mm. broad, extending around the stem like a ring; the nearly smooth upper portions of the sheaths and panicle branches are mottled with irregular yellow or brown, often purple-bordered spots. In the early flowering stage the culms are nearly always simple and support a single, long-exserted panicle; later the culms become much branched and the branches are terminated by more simple, fewer-flowered panicles which are partially inclosed in the leaf-sheaths. The primary panicle and sometimes the first culm leaves disappear and there is left a much-branched grass with numerous crowded small leaves and many, small, few-flowered, simple panicles. It was this late, much-branched form that Lamarck described as *Panicum pubescens*.

FIG. 11.—*Panicum scoparium* Lam: *a, b, c*, spikelets; *d*, third glume with palea; *e, f*, flowering glumes.

TYPE LOCALITY.—"Carolina," Michaux. Type specimen in the Herbarium of the Paris Museum of Natural History.

GENERAL DISTRIBUTION.—Low ground, swamps, borders of thickets, etc., Pennsylvania to Tennessee, Florida, Arkansas, and Texas. May to October.

SPECIMENS EXAMINED.—*Pennsylvania:* J. McMinn, no locality or date. Tinicum, 114 C. E. Smith; *Delaware:* Ellendale, 32 A. Commons, 1892; Millsboro, 28 A.

Commons, 1894. *District of Columbia:* G. Vasey, 1881; D. L. Topping, 1895; T. H. Kearney, 1895; Deanwood, E. D. Merrill, 1900. *Virginia:* Norfolk, 308 T. H. Kearney, 1895; Portsmouth, 88, 89 Noyes, 1896; Dismal Swamp, G. McCarthy, 1883. *North Carolina:* Wilmington, 4290 Biltmore Herbarium, 1897. *Georgia:* Yellow River, Gwinnett County, J. K. Small, 1893; Americus, S. M. Tracy, 1897. *Alabama:* Tuskegee, 52, 87 G. W. Carver, 1897; Cullman, C. Mohr, 1895; Auburn, 3978 S. M. Tracy, 1897. *Florida:* Baldwin, 67 R. Combs, 1898; Chipley to Bay Head, 616 Combs, 1898; Duval County, A. H. Curtiss; Apalachicola, A. W. Chapman, 4290*a* Biltmore Herbarium; Lake City, 2204 G. V. Nash, 1895. *Mississippi:* Pachuta, 3306 S. M. Tracy, 1897. *Louisiana:* Arcadia, 77 C. R. Ball, 1898. *Arkansas:* F. L. Harvey; Miller County, 116 H. Eggert, 1896; Texarkana, 4236 A. A. & E. G. Heller, 1898. *Texas:* Waller, F. W. Thurow, 1898; Fort Smith to Rio Grande, Choctaw Agency, J. M. Bigelow, 1853–54; Hempstead, 829 E. Hall, 1872; no locality, G. C. Nealley.

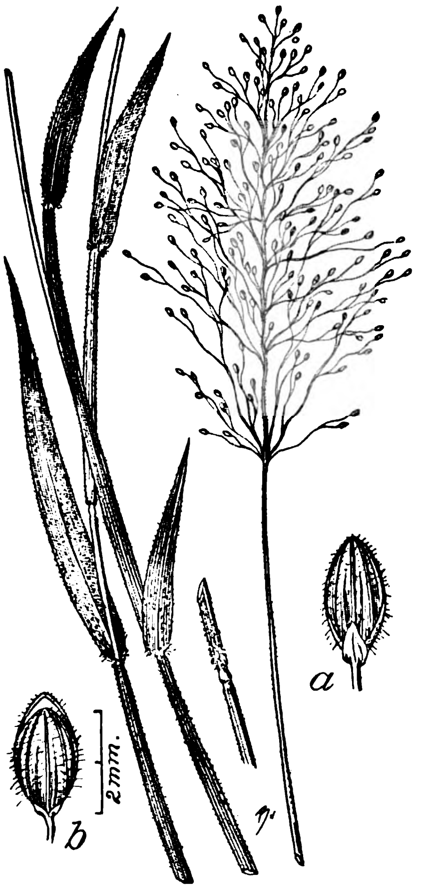

FIG. 12.—*Panicum scoparium* Lam.: *a, b,* spikelets. Drawn from type specimen in the Herbarium of the Paris Museum of Natural History.

There are two sheets of *Panicum scoparium* in the Herbarium of the Paris Museum, one with the following label: "*Panicum scoparium* Lam. donné par le C. Michaux, Herb. Mus. Paris, Herbier de Lamarck acquis en novembre, 1886," which is evidently Lamarck's type. (Fig. 12.) The second sheet is identical with this and bears the following label: "*Panicum scoparium* Lam. in pratis sylvestris, Carolina, Herb. Mus. Paris, Herbier de l'Amérique septentrionale d'André Michaux." Some American authors have recognized that *Panicum scoparium* of Michaux was identical with *P. viscidum* Ell., but wrongly considered Michaux's plant distinct from *Panicum scoparium* Lam. Both Lamarck's and Michaux's specimens of *P. scoparium* are identical with the form long known as *Panicum viscidum* Ell. For the plant wrongly considered by Elliott as *Panicum scoparium*, we propose the following name: **Panicum ravenelii** Scribn. & Merrill, nom. nov. (*Panicum scoparium* of Ell. Sk. Bot. S. C. and Ga. **1**: 119. 1817. Not Lam. Encycl. **4**: 744. 1797.)

Panicum pubescens Lam. is a late, much-branched form of *Panicum scoparium* Lam. In the Herb. Mus. Paris there is one sheet of this species bearing the following label: "*Panicum pubescens* Lam., Hab. in pratis sylvestribus Carolinæ ♃, no. 7, Herb. Mus. Paris, Herbier de l'Amérique septentrionale d'André Michaux." On this sheet are two specimens, one a fragment much dried and torn, the other

in good condition. (Fig. 13.) These specimens are identical and are matched by the following collections: 77 C. R. Ball, Louisiana, 1898; 3978 S. M. Tracy, Alabama, 1897.

While it is possible that the specimen cited by Lamarck as collected by Sherard in 1721 may be different from Michaux's plant, yet Lamarck's description is certainly that of the latter.

The appearance of the early simple form and the late branched form of this species is so different that it is not to be wondered at that Lamarck considered them

FIG. 13.—*Panicum pubescens* Lam: *a*, *b*, spikelets. Drawn from a specimen in the Herbarium of the Paris Museum of Natural History, by A. H. Baldwin.

distinct species and so described them, especially as he had only herbarium material to deal with.

The original descriptions of *Panicum scoparium* and *Panicum pubescens* are given below:

"*Panic en balais; Panicum scoparium.*

"Panicum panicula ramosa subnudiflora, glumis ovatis striatis villosulis, foliis brevibus pubescentibus.

"D'après les exemplaires de cette plante que j'ai vus dans l'herbier du citoyen Jussieu, sa tige doit avoit environ un pied & demi de longueur. Elle est

articulée, feuillée médiocrement, simple, pubescente. Les feuilles sont distantes, courtes, ovales-lancéolées, pointues, pubescentes, & larges d'environ six lignes. La panicule est terminale, longue de quatre ou cinq pouces, rameuse, velue sur son axe & ses principales ramifications, & paroît en grand partie dénuée de fleurs, sans doute par l'effet de la chûte prompte de celles qui se sont développées les premières. Les fleurs sont un peu pédicellées, ovales, striées, velues, mutiques. La troisième valve calicinale est courte, pointue, bien apparente.

"Cette plante a été recueillie dans la Basse-Caroline par le citoyen Michaux (v. s.)."[1] Lamarck, Encycl. **4**: 744 (1797).

This plant was collected in South Carolina by Michaux (v. s.).

"*Panic pubescent; Panicum pubescens.*

"Panicum pubescens panicula parva laxa sessili pauciflora, glumis ovatis subpedicellatis, culmo superne ramosissimo.

"Les tiges, les feuilles, la panicule & les bâles sont couvertes d'un duvet court, très-remarquable, qui donne à la plante une couleur cendrée ou blanchâtre. La tige, qui quelquefois n'a guère plus de six pouces de hauteur, s'élève d'autres fois à la hauteur d'un pied ou un peu plus. Elle est un peu coudée à ses articulations, dont les inférieures sont fréquentes, & se divise dans sa partie superieure en plusieurs ramifications presque dichotomes. Ses feuilles sont graminées, planes, ou presque planes, larges de deux à trois lignes, d'un vert glauque ou grisâtre, & pubescentes des deux côté, ainsi que sur leur gaîne. Les panicules sont terminales, petites, très-lâches, sessiles, & composées de trois ou quatre ramifications alternes, distantes & pauciflores. Les bâles sont ovales, un peu pédicellées & pubescentes comme les autres parties de la plante. J'ai vu de cette espèce un individu nain dans l'herbier de Vaillant; il l'avoit reçue de Sherard en 1721. Le citoyen Michaux l'a trouvée dans la Basse-Caroline (v. s.)."[2] Lamarck, Encycl. **4**: 748 (1797).

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[1] According to specimens of this plant which I have seen in the herbarium of Jussieu, the culm was about a foot and a half high. It is articulate, sparingly branched, simple, pubescent. The leaves are distant, short, oval-lanceolate, pointed, pubescent, and about 6 lines wide. The panicle is terminal, 4 or 5 inches long, branching, downy on its axis and its principal branches, and seems to be almost entirely bare of flowers, doubtless due to the early fall of those which developed first. The flowers are short-pedicelled, oval, striate, downy, muticous. The third glume is short, pointed, very prominent.

[2] Culms, leaves, panicle, and spikelets are covered with a very peculiar short down, which gives the plant an ashy or whitish color. The culm, which sometimes is not more than 6 inches high, at other times reaches the height of a foot or more. It is slightly bent at its articulations, the lower of which are numerous, and is divided above into several nearly dichotomous branches. The leaves are grasslike, flat, or nearly so, 2 or 3 lines wide, glaucous green or grayish, and pubescent on both sides, as is also the sheath. The panicles are terminal, small, very lax, sessile, and composed of three or four alternate branches, distant and few-flowered. The spikelets are oval, shortly pedicelled and pubescent like the other parts of the plant. I have seen a dwarfed individual of this species in the herbarium of Vaillant, who had received it from Sherard in 1721. Michaux found it in South Carolina (v. s.).

III.—MISCELLANEOUS NOTES AND DESCRIPTIONS OF NEW SPECIES.

By F. Lamson-Scribner and Carleton R. Ball.

The notes and new species presented in the following pages were for the most part elaborated in the preparation of a complete list of the grasses of the Gulf States to accompany a report on the economic grasses of that region. It is believed that the recognition of the five species of *Elymus* will greatly facilitate a better understanding of that genus in the Eastern and Southern States, from both the economic and systematic standpoints. F. L.-S.

ANDROPOGON ARGYRÆUS MACRUS Hack. in litt.

Sheaths mostly sparingly long-hirsute; leaves scabrous or sometimes sparingly hirsute above; spikes 1 to 2 cm. long; spikelets 6 to 7 mm. long, otherwise as in the species.

Type collected by S. M. Tracy, No. 3891, Biloxi, Mississippi, October 31, 1897.

Specimens examined.—*Florida:* Apalachicola, A. W. Chapman; McDonald, Orange Co., 57 C. H. Baker, November, 1897. *Mississippi:* Biloxi, 3892, 3900 S. M. Tracy, October, 1898; Columbus, 2954 S. M. Tracy, October, 1895.

ANDROPOGON BAKERI sp. nov. (Fig. 14.)

A tall, stout perennial, with the short spikes borne on long, slender peduncles; Culms 10 to 11 dm. high, smooth or slightly roughened below the upper nodes. lower internodes strongly compressed, the upper terete; sheaths much longer than the internodes, loose, smooth or sparsely hirsute, the lower compressed, keeled, equitant, the upper inclosing the bases of the panicles; ligule membranous, 1 mm. long, fringed with short bristles; leaf-blades 2 to 4 dm. long, 5 to 7 mm. wide, flat, smooth below, somewhat scabrous above. Panicle about 2.5 cm. long, with slender, appressed or somewhat spreading branches, 3 to 4 at each node; joints of the primary branches 3 to 4, secondary 2 to 3, and tertiary usually 1. Spathes 4 to 5 cm. long, green, acuminate, exceeding or somewhat shorter than the racemes. Racemes two, 1.5 to 3 cm. long, 3 to 6 flowered; rachis slender, internodes somewhat clavate, 4 mm. long, shorter than the spikelets, densely clothed with long, silky, white hairs, exceeding the internodes in length. Sessile spikelets yellowish, linear-lanceolate, 5 mm. long; callus barbate with white hairs 2 mm. long; first glume smooth or the keels minutely scabrous, bifid at the apex, 5 mm. long; second glume firm, keeled, scabrous on the keel, 4.5 mm. long, bidentate at apex; third glume hyaline, acuminate; fourth glume hyaline, acuminate, bifid at the apex, and bearing a straight, slender awn 7 to 10 mm. long. Grain fusiform, plano-convex, acute at apex, 3.5 mm. long, tipped with the persistent style. Sterile pedicel about 7 mm. long, erect, densely clothed with long white hairs; sterile spikelet entirely wanting.

Type collected in pine lands at Grasmere, Florida, 58 C. H. Baker, November 13, 1897.

ANDROPOGON LINNAEANUS (Hack.) Scribn. & Kearney, n. comb. (*Sorghum nutans Linnaeanum* Hack. in Mart. Fl. Bras. **2**[3]: 276 (1878); *Andropogon nutans Linnaeanus* Hack. in DC. Monog. Phan. **6**: 531 (1889).)

ANDROPOGON MISSISSIPPIENSIS sp. nov. (Fig. 15.)

A rather small perennial, 4 to 7 dm. high, with few, short-peduncled spikes. Culms slender, smooth, purplish where exposed, the lower internodes somewhat compressed; sheaths about one-half as long as the internodes, strongly striate, densely hirsute or papillose-hirsute with white hairs 2 to 3 mm. long, the lower ones equitant, crowded; ligule a very short membranous ring; leaf-blades 1 to 2.5 dm. long, 2 to 3 mm. wide, acuminate, flat, hirsute below, papillose-hirsute above, midrib and margins strongly scabrous. Panicle 2 to 2.5 dm. long, slender, interrupted, nearly simple; branches 7 to 15 cm. long, appressed, single, 2-noded. Spathe 4 to 4.5 cm. long, equaling or shorter than the racemes, abruptly acuminate into an awn 2 to 3 mm. long. Racemes in pairs, 2 to 4 cm. long, 6 to 12 flowered; internodes somewhat clavate, shorter than the spikelets, 2.5 mm. long, densely clothed with long, white, silky hairs, 5 to 7 mm. long; sessile spikelet yellowish, linear-lanceolate, 4 mm. long; callus barbate with hairs 3 mm. long; first glume hispid-scabrous on the flat or depressed back and on the keels, especially toward the apex, nerveless between the keels, 3.5 to 4 mm. long, 1 to 1.2 mm. broad; second glume firm, strongly compressed, keeled, scabrous on the keel, hirsute on the margins, 3.5 mm. long, bidentate at the acute apex; third and fourth glumes hyaline, acuminate, the fourth bearing an erect, slender awn, twisted at the base, 1.5 to 2 cm. long; sterile pedicel 4 mm. long, slender, densely clothed with long, white, silky hairs; sterile spikelet reduced to a single scale 2 to 3 mm. long.

FIG. 14.—*Andropogon bakeri* Scribn. & Ball: *a*, a spikelet and joint of the axis: *b*, first glume; *c*, second glume; *d*, third glume; *e*, awned fourth glume; *f*, pistil and lodicules.

Related to *A. argyræus*, but easily separated by the hirsute sheaths and leaves, the narrow, simpler, interrupted panicle, and broader, scabrous first glume. Distinguished from *A. cabanisii* by its hirsuteness and by the nerveless intercarinal space of the first glume.

Type collected at Biloxi, Mississippi, 3818 S. M. Tracy, October 14, 1897. No. 3817 S. M. Tracy also belongs here.

ANDROPOGON SCOPARIUS POLYCLADUS var. nov.

Stout, 9 to 12 dm. high, glabrous, somewhat glaucous; panicles large, much branched, 3 to 5 dm. long.

Type collected at Braidentown, Manatee County, Florida, 1298 Robert Combs, October 3, 1898. "In old fields and orange groves along the Manatee; abundant in places." Tracy's No. 5330, from Biloxi, Mississippi, and a plant collected by John K. Small on the slopes and summit of Stone Mountain, Georgia, September 6–12, 1894, belong here.

ANDROPOGON SCOPARIUS VILLOSISSIMUS Kearn. var. nov.

Sheaths and usually the blades villous.

Type collected in very dry soil along the railroad at Waynesboro, Mississippi, 136 T. H. Kearney, jr., October 2, 1896. Other specimens are: *North Carolina:* Clarkton, Bladen County, 20*b* Biltmore Herbarium, October, 1897. *Florida:* Grasmere, 1156 R. Combs and C. H. Baker, September, 1896; McDonald, Orange County, 139 C. H. Baker, November, 1898; Tampa, 1371 R. Combs, October, 1898. *Mississippi:* Saltillo, S. M. Tracy, October 18, 1892. *Louisiana:* Lake Charles, 3702, 3703 S. M. Tracy, August, 1897; Oberlin, 219 C. R. Ball, September, 1898.

FIG. 15.—*Andropogon mississippiensis* Scribn. & Ball: *a*, a spikelet, showing joint of axis, etc.

Paspalum altissimum Le Conte, Journ. Phys. **91**: 285 (1820).

"13. *Altissimum.* Glabrum, erectum, altum; foliis longis, basi vaginisque ad oras ciliatis; spicis 4–5 alternis, erectis, basi pilosis; glumis magnis, orbiculatis, biseriatis; rachi latiuscula, dentibus unifloris. Gramen rigidum, quinque pedale. Habitat prope Salem Carolinæ borealis. ♃."

Dr. Vasey, in his notes on Le Conte's *Paspalums*,[1] refers this to *P. floridanum* Mx., with which it has always been confounded. He also calls attention to the fact that Le Conte's type has but two racemes, although the description reads "racemis 4–5." Le Conte described a form of *P. læve* Mx. as *P. floridanum* Mx.

P. altissimum is intermediate between *P. floridanum* Mx. and *P. bifidum* (Bertol) Nash, with slender, erect culms, hirsute sheaths and long, slender leaves, hirsute above and often below also. Racemes 1 to 3, rather loosely flowered.

GENERAL DISTRIBUTION.—Not uncommon in rather dry, open pine lands near the coast, from the Carolinas to Louisiana.

SPECIMENS EXAMINED.—*South Carolina:* Florence, 688 C. R. Ball, August, 1900. *Florida:*

[1] Proc. Acad. Nat. Sci. Phil. **1886**: 288 (1886).

no locality, A. W. Chapman; Bay Head, 636 R. Combs, August, 1898; Chipley, 594 R. Combs, August, 1898; De Funiak Springs, 471 R. Combs, August, 1898; Jacksonville, 149 T. H. Kearney, jr., July, 1895; Marianna, 3669 S. M. Tracy, August, 1897; Monticello, 343 R. Combs, August, 1898. *Georgia:* Thomasville, 3671 S. M. Tracy, August, 1897. *Alabama:* no locality, 333 A. Winchell; Mobile, C. Mohr. *Mississippi:* Bay St. Louis, 21 A. B. Langlois, September, 1883; Biloxi, 3743 S. M. Tracy, September, 1897; Nicholson, 345 T. H. Kearney, jr., 1896; Ocean Springs, 23 S. M. Tracy, August, 1889; 289 T. H. Kearney, jr., October, 1896; Waynesboro, 143 T. H. Kearney, jr., October, 1896. *Louisiana:* Alexandria, 171 C. R. Ball, September, 1898.

FIG. 16.—*Panicum combsii* Scribn. & Ball: *a*, spikelet; *b*, second glume; *c*, *d*, flowering glumes.

PASPALUM PASPALOIDES VILLOSUM (Vasey) n. comb. (*P. furcatum villosum* Vasey, Contr. U. S. Nat. Herb. **3:** 16 (1892).)

PANICUM COMBSII sp. nov. (Fig. 16.)

A slender, rather densely cæspitose, erect perennial 3 to 6 dm. high, from short, creeping root-stocks, with linear flat leaves and spreading, nearly simple, few-flowered panicles 8 to 15 cm. long. Culms somewhat compressed below, glabrous or minutely puberulent just below the nodes; sheaths more or less compressed, glabrous; ligule very short, ciliate; leaves of the culm 10 to 20 cm. long, 3 to 5 mm. wide, very acute, minutely serrulate-scabrous on the margins, otherwise smooth. Panicle branches more or less spreading, usually solitary, the lower 5 to 7 cm. long; pedicels as long as or shorter than the spikelets, rarely exceeding them, appressed. Spikelets lanceolate acute, 3 mm. long; first glume broadly lanceolate, acute, 3-nerved, scabrous on the midnerve toward the apex, two-thirds to three-fourths the length of the spikelet; second glume as long as the third glume, 5-nerved, nerves scabrous above; third glume 3 or imperfectly 5-nerved, the marginal nerves faint, indistinctly acuminate-pointed, subacute with a hyaline palea nearly three-fourths its length; flowering glume about 2 mm. long, much shorter than the second and third glumes, narrowly oblong, obtuse, with a few short hairs at the apex; palea scabrous on the keels.

Type collected by Robert Combs, No. 583, for whom the species is named, in damp, fertile flat woods at Chipley, Washington County, Florida, August 20, 1898. A specimen, No. 571, collected August 19, in water of a cypress pond is referred here.

P. combsii belongs to the group including *P. agrostoides* Muhl. and *P. longifolium* Torr., but is separated from these by its low tufted habit, shorter, narrow leaves, long, slender spikelets, and elongated lower glume.

ARISTIDA COMBSII sp. nov. (Fig. 17.)

A tall, strict, leafy perennial, 8 to 12 dm. high, with long, rigid leaves and large compound panicles. Culms simple, terete, smooth. Sheaths longer than the internodes, smooth, striate, 1 to 1.5 dm. long, lower mostly purple; ligule a very short ring; leaf-blades linear, rigid, erect, attenuate into a long subulate point, 3 to 6 dm. long, 2 to 4 mm. wide, flat or semi-involute, smooth below, scabrous and somewhat glaucous above. Panicle large, 4 to 6 dm. long, strict or somewhat flexuous; rachis scabrous; branches long, ascending or suberect, straight or flexuous, compound, scabrous, single or in pairs, one short and few-flowered, the lower longer ones 1 to 2.5 dm. in length, naked at the base for one-fourth their length. Spikelets in pairs, one almost sessile, the other on a pedicel one-half as long as the spikelet; empty glumes lanceolate, one-nerved, 9 to 10 mm. long, including awns, subequal or the upper usually 0.5 to 1 mm. longer, scabrous on the keels or the lower all over, tipped with an awn 0.5 to 1 mm. long, longest on the lower glume; flowering glume 7 to 8 mm. long, slightly scabrous toward the apex; callus barbate, 1 mm. long; awns nearly equal, scabrous, spreading, middle awn 18 to 22 mm. long, lateral awns 16 to 20 mm. long.

FIG. 17.—*Aristida combsii* Scribn. & Ball: *a*, spikelet; *b*, palea.

Type specimen collected by Robert Combs and C. H. Baker, No. 1069, at Grasmere, Florida, September 21, 1898.

A species with the habit and in part the appearance of *A. palustris* (Chapm.) Vasey, but with a very distinct type of inflorescence.

GENERAL DISTRIBUTION.—Common in high pine and blackjack lands of central peninsular Florida.

SPECIMENS EXAMINED.—*Florida:* Bartow, Polk County, 1190 R. Combs, September, 1898; Clarcona, Orange County, 81 Marie Meislahn, October, 1899; Crystal, Citrus County, 1015 R. Combs, September, 1898; Eustis, Lake County, 1736 G. V. Nash, August, 1894; Fannin, Levy County, 869 R. Combs, September, 1898; Old Town, Lafayette County, 898*a* R. Combs, September, 1898; Tampa, Hillsboro County, 1386 R. Combs, October, 1898.

ARISTIDA INTERMEDIA sp. nov. (Fig. 18.)

A slender, somewhat geniculate, branching annual, 3 to 7 dm. high, with involute leaves and long, slender panicles. Culms smooth, freely branching, purplish, the outer branches geniculate, ascending; sheaths usually shorter than the internodes, smooth or the lower sparsely hirsute, especially on the margins, and purplish; ligule a very short ring, 0.4 mm. long or less, fringed with short hairs; blades 5 to 15 cm. long, 2 mm. wide, erect, rigid, involute, sometimes sparsely hirsute near the base. Panicle 2 to 4 dm. long, slender, often flexuose; branches short, 2 to 4 cm. long, appressed. Spikelets 8 to 10 mm. long; empty glumes narrowly lanceolate, attenuate into a rather long awn, nearly equal or the upper longer, 7 to 9 mm. long, 1-nerved, scabrous, purplish; flowering glume 7 to 9 mm. long, strongly scabrous above the middle, equaling or exceeding the empty glumes, sometimes regularly spotted as in *A. gracilis;* awns all spreading, the middle one 18 to 22 mm. long, the lateral ones 14 to 17 mm. long, all variable. This species is most closely allied to *A. gracilis*, but differs in its larger size and especially in the much longer florets and awns. It is nearly intermediate between *A. gracilis* and *A. purpurascens*, with the habit of the former and spikelets more like those of the latter.

FIG. 18.—*Aristida intermedia* Scribn. & Ball: *a*, spikelet.

Type collected by T. H. Kearney, jr., No. 204, near Biloxi, Mississippi, October 5, 1896.

GENERAL DISTRIBUTION.—Open, dry, sandy soil, Iowa to Texas and Mississippi.

SPECIMENS EXAMINED.—*Iowa:* Wapsipinicon River, 31 E. N. Wilcox, October, 1896. *Missouri:* Courtney, 649 B. F. Bush, August, 1896. *Nebraska:* Ewing, 1075 J. M. Bates, August, 1897; Simeon, 1115 J. M. Bates, 1897. *Kansas:* Riley County, 425 A. S. Hitchcock, August, 1895. *Arkansas:* Jefferson County, 125 H. Eggert, September, 1896. *Texas:* no locality, S. B. Buckley, 1883; G. C. Nealley, 1889; J. Reverchon, F. W. Thurow. *Louisiana:* Arcadia, 78 C. R. Ball, August, 1898. *Mississippi:* Biloxi, 207, 236 T. H. Kearney, jr., October, 1896; 3774 S. M. Tracy, September, 1897; Horn Island, 1578 S. M. Tracy, September, 1891.

ARISTIDA PURPURASCENS GLAUCISSIMA Kearn. var. nov.

Whole plant very glaucous, otherwise like typical *A. purpurascens.* Conspicuous in the field on account of its bluish-white color.

Type collected by T. H. Kearney, jr., No. 321, in very dry, sterile soil in an opening in the pine forest, 6 miles above Biloxi, Mississippi, October 7, 1896.

TRIODIA SESLERIOIDES ARISTATA var. nov.

A robust grass, 12 to 18 dm. high. Panicle large, open, its lower branches 2 to 2.5 dm. long; excurrent tips of the nerves in the flowering glume 1 to 1.5 mm. long.

Type collected by Miss Marie Meislahn, No. 90, at Clarcona, Orange County, Florida, October (?), 1899.

GENERAL DISTRIBUTION.—Not uncommon in low, open woods of central Florida.

FIG. 19.—*Elymus arkansanus* Scribn. & Ball: *a*, dorsal and anterior views of the flowering glume; *b*, empty glumes.

SPECIMENS EXAMINED.—*Florida:* Grasmere, 1135 R. Combs and C. H. Baker, September, 1898; Homosassa, 978 R. Combs, September, 1898; McDonald, 132 C. H. Baker, October, 1898; Oakwood, Duval County, 322 A. Fredholm, October, 1893; Ormond, 5562 A. H. Curtiss, September, 1895.

ELYMUS ARKANSANUS sp. nov. (Fig. 19.)

A slender, erect perennial, with a short, broad, bristly, nodding spike. Culms 6 to 8 dm. high, terete, smooth; nodes smooth; sheaths mostly a little shorter than the internodes, ciliate on the margins or the lower sparsely hirsute-pubescent; ligule less than 1 mm. long, membranaceous; leaf-blades 1 to 2 dm. long, 5 to 8 mm. wide, narrowly lanceolate-acuminate, erect or ascending, auricled at the base, scabrous below and on the margins, finely and densely pubescent above.

Spike long-exserted on the slender pedicel, nodding, 6 to 9 cm. long; internodes of the rachis angular, somewhat compressed, hispid-ciliate on the margins, 3 to 4 mm. long. Spikelets 2 at each joint, 2-flowered, the upper very small; empty glumes divergent, linear-subulate, cylindrical and coriaceous at base, flattened, scabrous, and 2 or 3 nerved above, 8 to 10 mm. long, or, including the stout, straight, scabrous awn, 2 to 3 cm. long; flowering glume narrowly lanceolate, acute, raised on a short stipe and separating from it by a horizontal constriction, minutely scabrous, 3 to 5 nerved at apex, 7 mm. long, terminating in a straight, slender, scabrous awn 2 to 4 cm. long. Palea slightly shorter than its glume, rounded or slightly bidentate at apex, hispid on the keels above.

E. arkansanus is allied to *E. striatus*, from which it is distinguished by having the empty and flowering glumes minutely scabrous instead of hirsute.

Type collected by F. L. Harvey (Arkansas Flora 7, in part) in woods of northwestern Arkansas. The same sheet bears also a specimen of *E. striatus*.

SPECIMENS EXAMINED.—*Arkansas:* Fort Smith, Dr. J. M. Bigelow, in Whipple's Exploration, 1853–1855. *Missouri:* Springfield, S. A. Hoover, 1897. *Iowa:* Nodaway River, Adair County, F. C. Stewart, July, 1892 (Herb. Iowa State College).

FIG. 20.—*Elymus australis* Scribn. & Ball: *a*, a single spikelet, showing hairy glumes.

ELYMUS AUSTRALIS sp. nov. (Fig. 20.)

A tall, stout perennial with broad leaves and a large bristly spike. Culms erect, 9 to 14 dm. high, terete, smooth; nodes smooth; sheaths scabrous-hirsute, especially on the margins, longer or shorter than the internodes, the upper ones smooth and somewhat inflated; ligule a mere ring less than 0.5 mm. long, entire; leaf-blades ascending, 2 to 3 dm. long, 1 to 1.5 cm. wide, acuminate, strongly scabrous below, scabrous or scabrous-hirsute above. Spike robust, bristly, 1 to 1.3 dm. long, the peduncle exserted, 0.5 to 1.5 dm.; rachis angular, compressed, scabrous-pubescent on the margins and on the back above. Spikelets 2 at each node, 4 to 5 flowered; empty glumes divergent, thickened, coriaceous and somewhat curved at the base, 5-nerved above, scabrous-hirsute or rarely nearly smooth, about 1.5 cm. long, tipped with a short, straight awn of equal length; flowering glume borne on a stout stipe, lanceolate, 8 to 10 mm.

long, hirsute, tipped with a short, straight, scabrous awn 2.5 to 3 cm. long. Palea a little shorter than its glume, obtuse or minutely bidentate, scabrous between the keels.

This species has heretofore been referred to *E. canadensis* L., *E. virginicus* L., *E. striatus* Willd., and *E. hirsutiglumis* Scribn. From the first it is distinguished by the thickened, hirsute, empty glumes; from *E. virginicus* L. by its hirsute spikelets and longer awns; from *E. striatus* Willd. by more robust culms and spikes and by the thickened 5-nerved empty glumes, while it may be separated from *E. hirsutiglumis* Scribn., its nearest ally, by its more robust spikes and longer glumes and awns.

Type from Biltmore Herbarium, No. 411*b*, collected on banks of streams at Biltmore, North Carolina, July 7, 1897.

General distribution.—Moist woods and thickets from North Carolina and Florida west to Arkansas and Missouri.

Specimens examined.—*Florida:* no locality, A. H. Curtiss, 1886. *Alabama:* Valley Head, 38 A. Ruth, July, 1898. *Georgia:* Augusta, 222 T. H. Kearney, jr., July, 1895; Luluh Falls, Lookout Mountain, 16 A. Ruth, 1898. *Arkansas:* White River, near Batesville, F. V. Coville, August 2, 1887. *Missouri:* St. Louis, 195 H. Eggert, July, 1879. *Illinois:* no locality, J. Wolf, 1882.

Fig. 21.—*Elymus brachystachys* Scribn. & Ball: *a*, a single spikelet; *b*, the same with the outer glumes removed.

ELYMUS BRACHYSTACHYS sp. nov. (Fig. 21.) (*Elymus canadensis glabriflorus* Vasey, Contr. U. S. Nat. Herb. **2**: 550 (1894) (in part).)

A low but rather stout perennial with bristly nodding spikes. Culms 3 to 9 dm. high, erect or somewhat geniculate at base, smooth, terete; nodes smooth; sheaths mostly shorter than the internodes, smooth, striate; ligule a short, entire ring, less than 1 mm. long; leaf-blades 1 to 2 dm. long, 6 to 11 mm. wide, acuminate, ascending, semi-involute, smooth or somewhat scabrous below, finely scabrous above and on the margins. Spike rather dense, 8 to 15 cm. long, long-exserted on a stout peduncle; rachis thickened, striate, 4-angled or more compressed and 2-angled, entirely smooth or scabrous on the angles. Spikelets glabrous, 2 at each joint, 3 to 5 flowered; empty glumes flat, scabrous, 8 to 10 mm. long or with the straight scabrous awn 2.5 to 3.5 cm. long, 1 mm.

wide, 3 or rarely 5 nerved; flowering glume smooth or minutely scabrous, borne on a short stipe, 11 to 13 mm. long, 5-nerved, the nerves next the keel often shortly excurrent, tipped with a straight or sometimes divergent scabrous awn 2 to 4 cm. in length. Palea about 10 mm. long, narrow, tapering to a narrow, truncate, or minutely bidentate point, scabrous on the keels.

Closely allied to *E. canadensis* L., but easily distinguished by its smaller size and the scabrous but not hirsute flowering glumes.

GENERAL DISTRIBUTION.—Moist, open or somewhat shaded ground, from Michigan and South Dakota south to Texas, New Mexico, and into Mexico.

Type specimen collected by Dr. Edward Palmer, No. 420, "in the Indian Territory, chiefly on the False Washita, between Fort Cobb and Fort Arbuckle, 1868."

SPECIMENS EXAMINED. — *Michigan:* "Southern Michigan," 1409 O. A. Farwell, August, 1893. *Iowa:* Several specimens in Herb. Iowa State College from western and northern Iowa. *South Dakota:* Hot Springs, 1173, 1174 P. A. Rydberg, August, 1892. *Colorado:* Colorado Springs, 734 C. L. Shear, July, 1896; Walsenburg, Huerfano County, 778 C. L. Shear, July, 1896; Chase, Park County, 1101 C. L. Shear, September, 1896; "along Burl. and Mo. R. Ry.," L. H. Pammel, July, 1896. *Kansas:* Manhattan, W. A. Kellerman, July, 1888; Osborne, 709 C. L. Shear, June, 1896; Syracuse, 135 C. H. Thompson, July, 1893. *Texas:* Austin, 34 E. N. Plank, July, 1892; Kerrville, J. G. Smith, June, 1897; no locality, 571 F. Lindheimer, 1846. *New Mexico:* 2075 C. Wright, 1851–52. *Mexico:* Saltillo, Coahuila, 260 Dr. E. Palmer, June, 1898.

FIG. 22.—*Elymus diversiglumis*, Scribn. & Ball: *a*, anterior view of a floret and dorsal view of apex of a flowering glume.

ELYMUS DIVERSIGLUMIS sp. nov. (Fig. 22.)

A rather stout, erect perennial, 9 to 12 dm. high, with a slender, flexuous spike 1 to 1.5 cm. long, and the empty glumes reduced or nearly wanting. Culms terete, glabrous; nodes glabrous; sheaths glabrous, striate, nearly equaling or longer than the internodes; ligule membranaceous, less than 2 mm. long; leaf-blades spreading, 1.5 to 2.5 cm. long, 6 to 12 mm. wide, tapering to a long-acuminate point, scabrous on both surfaces and the margins; rachis rather slender, compressed, smooth or scabrous-ciliate on the edges and upper part of each internode. Spikelets in pairs, 2-flowered; empty glumes subulate, scabrous, varying from

a mere point to 1.5 cm. in length in the same spikelet; flowering glumes, on a short stipe, linear-lanceolate, acute, 8 to 10 mm. long, indistinctly 3 to 5 nerved, scabrous and thinly hirsute, tipped with a stout, divergent, scabrous awn, 2 to 3 cm. long. Palea equaling or slightly shorter than the glume, bidentate, minutely scabrous.

This species is closely allied to *E. canadensis*, but is readily distinguished by the more slender, open infloresence and the unequal and much reduced empty glumes.

Type collected by T. A. Williams, No. 2653, in rich openings of the Bear Lodge Mountains, Wyoming, July 23, 1897, altitude 6,000 feet.

SPECIMENS EXAMINED.—*Wisconsin:* No locality, F. F. Wood. *North Dakota:* Turtle

FIG. 23.—*Elymus glabriflorus* (Vas.) Scribn. & Ball: *a*, a single spikelet, showing the outer glumes; *b*, anterior view of a floret.

Mountains, Bottineau County, 85 M. A. Brannon, July, 1896; Langdon, 150 M. A. Brannon, July, 1896. *Wyoming:* Welcome, 2679, 2681 T. A. Williams, July, 1897.

ELYMUS GLABRIFLORUS (Vasey) n. comb. (*E. canadensis* var. *glabriflorus* Vasey, in Dewey, Contr. U. S. Nat. Herb. **2**: 550 (1894).) (Fig. 23.)

A tall, stout, leafy perennial with large leaves and long, dense spike. Culms stout,

erect, 6 to 10 dm. high, smooth, terete; nodes smooth; sheaths crowded, longer than the internodes, smooth or rough-hirsute, loose; ligule less than 1 mm. long, entire; leaf-blades numerous, 1.5 to 3 dm. long, 7 to 10 mm. wide, flat or partially involute, erect or ascending, somewhat scabrous below, scabrous on the margins and scabrous and sometimes sparsely hirsute above; spike robust, erect or nodding, 1 to 1.5 dm. long, often glaucous; rachis thick, somewhat compressed, smooth or ciliate, scabrous on the margins. Spikelets 2 to 3 at each node, 3 or 5 flowered; empty glumes thickened, coriaceous and somewhat curved at the base, strongly 3 to 5 nerved, scabrous on the nerves and often ciliate-scabrous on the margins, 11 to 15 mm. long, or with the straight, scabrous awn 3 to 3.5 cm.; flowering glumes on a short stipe, 9 to 12 mm. long, minutely scabrous, tipped with a straight, slender, scabrous awn 2 to 3 cm. long. Palea 8 to 10 mm. long, scabrous on the keels, truncate or minutely bidentate.

This species is more closely allied to *E. australis*, of which it is a glabrous-flowered counterpart, than to *E. canadensis*, from which it is distinguished by the heavier spikes, thickened empty glumes, and merely scabrous flowering glumes, while these first two characters serve to separate it from *E. brachystachys*. It seems unfortunate that this plant should have received the name *E. canadensis glabriflorus* when *E. brachystachys* really stands in that relationship to *E. canadensis*.

Type specimen collected in low, miry, even saltish places at Pointe-à-la-Hache, Louisiana, by A. B. Langlois, No. 81, June, 1885.

GENERAL DISTRIBUTION—Low, rich woods or thickets from Pennsylvania and Georgia to Tennessee and New Mexico.

SPECIMENS EXAMINED.—*Pennsylvania:* Easton, T. C. Porter, August 13, 1897; Philadelphia, 47 C. E. Smith, August. *District of Columbia:* Tennallytown. *Maryland:* Glen Echo, 15 T. H. Kearney, jr., August, 1894; Hamilton Hill, 701 C. R. Ball, July, 1900. *Virginia:* Norfolk, 293 T. H. Kearney, jr., August, 1895; Portsmouth, 36, 37 Noyes, 1895. *North Carolina:* Columbus, E. C. Townsend, 1897. *South Carolina:* Florence, 686 C. R. Ball, August, 1900. *Georgia:* Banks of the Coosa, mountains of Georgia, 23 A. W. Chapman, 1883. *Tennessee:* Cowan, 23 A. Ruth, July, 1898. *Alabama:* De Kalb County, 6 H. Eggert, June, 1897; Nesheka, 9 G. W. Carver, July, 1897. *Louisiana:* Arcadia, 84 C. R. Ball, August, 1898; Pointe-à-la-Hache, 81 A. B. Langlois (type). *Texas:* Ennis, J. G. Smith, July, 1898; no locality, G. C. Nealley, 1886; F. W. Thurow, 1889. *New Mexico:* 2073 C. Wright, 1851–52.

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[Synonyms in italics.]

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1895.	Forage Conditions of the Prairie Region. Exhausted.
1896.	Timothy in the Prairie Region.
1896.	Cowpeas. (Reprinted and published as Farmers' Bulletin No. 89.)
1897.	The Division of Agrostology.
1897.	Lawns and Lawn Making.
1897.	Leguminous Forage Crops.
1898.	Sand-binding Grasses.
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